The Engineer

LONDON, FRIDAY, JANUARY 17, 1941.

PUBLIC NOTICES

WIGAN AND DISTRICT MINING AND TECHNICAL COLLEGE

TEMPORARY TEACHER OF GEOMETRICAL DRAWING AND ELEMENTARY MATHEMATICS

The Governing Body Invites APPLICATIONS for a POST as TEMPORARY TEACHER of GEOMETRICAL DRAWING and ELEMENTARY MATHEMATICS. Duties to commence on 27th January or as soon as possible thereafter.

Candidates should have good drawing-office experience, together with some teaching experience, preferably with boys. Practical workshop experience in engineering or woodworking will be an additional recommendation. Salary in accordance with Burnham Technical Scale. A special allowance might be paid to an exceptionally well-qualified candidate.

Further particulars and application form will be sent by the undersigned on receipt of a stamped addressed foolscap envelope. Completed forms should be sent in as soon as possible.

J. F. S. ROSS, M.C., B.Sc., Ph.D.,
Principal.

10th January, 1941. 7046

SITUATIONS OPEN

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TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1940 No. 877

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WANTED by a Leading Engineering Insurance Company, additional BOILER INSPECTORS. Age 28 to 32. Applicants must be practical Engineers with technical training, holding a First Class or Extra First Class Board of Trade Certificate, capable of making accurately dimensioned sketches of all classes of Steam Boilers and writing clear reports on condition. Commencing salary £275 per annum.—Address, 7036, The Engineer Office. 7036 A

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The Engineer

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IMPORTANT NOTICE

All correspondence dealing with Editorial, Advertising and Subscription Matters should be addressed to: 28, ESSEX STREET, STRAND, LONDON, W.C. 2

Remittances and Letters dealing with Accounts should be sent to:

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CLASSIFIED ADVERTISEMENTS CLOSE FOR
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The Engineer
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BRITISH ISLES	£3	5	0	
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"THE METALLURGIST."

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER each alternate month. Next date, February 28th.

ADVERTISEMENTS.

The charges for Classified Advertisements are 1/- per line up to one inch—minimum charge 4/-; those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.

Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

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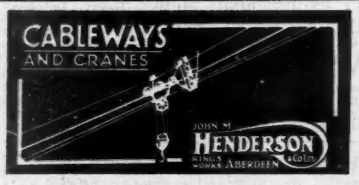

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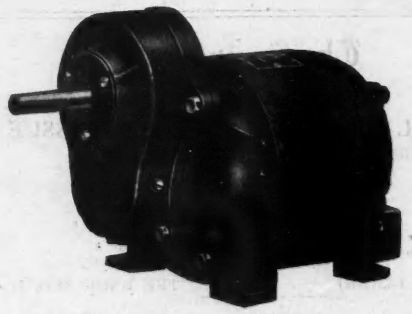

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EGB/39/A

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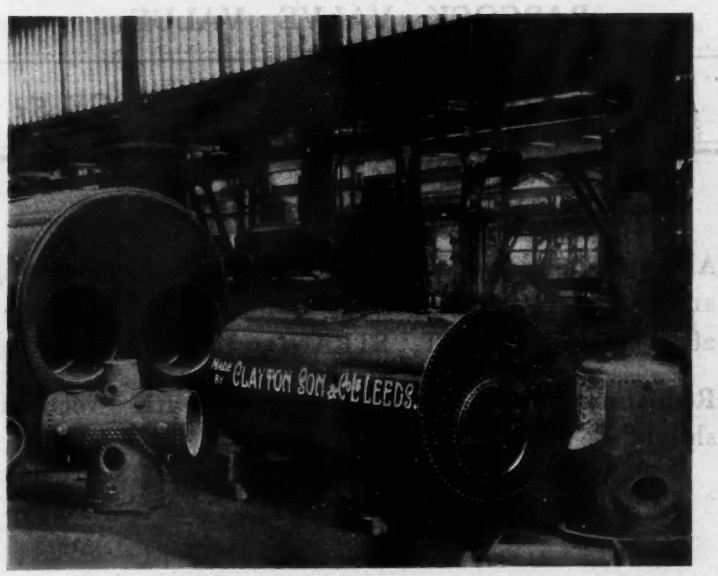

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With a FOREWORD by D. A. BREMNER, O.B.E., M.I.Mech.E., M.I.E.E., Director, British Engineers' Association
By C. W. HANSON.

Those Manufacturers—and there must be not a few—who feel that they may not be getting the best out of their advertising appropriation would do well to obtain copies of this little book and let them be read by those members of their Boards and Staffs who are concerned with publicity. Published by MORGAN BROTHERS (Publishers) LTD.

Price 3/6 post free. Obtainable from THE MANAGER, **"THE ENGINEER," 28, ESSEX STREET, STRAND, LONDON, W.C.2.**

A Seven-Day Journal

New British Aircraft

IN addition to the "Whirlwind," which, as Lord Beaverbrook recently announced, is now in service with the R.A.F., new British aircraft, it is permissible to state, include the Hawker "Tornado" single-seater fighter and the Short "Stirling" heavy bomber. The "Tornado" is equipped with a Rolls-Royce "Vulture" engine delivering, at present, 1750 H.P., but capable, it is believed, of being pushed up to 2000 H.P. In an American aviation journal it was stated recently that this machine has a top speed of 425 miles an hour and is equipped with fourteen or sixteen machine guns or, alternatively, with a proportion of cannon. These figures should, however, be accepted with reserve. The "Stirling" is stated to be the largest bombing aircraft as yet standardised in service. It has four engines, delivering a total of more than 5500 H.P. Its bomb load is said to be greater than that of any other existing bomber, while its range should enable it to reach very far distant objectives. A third new machine which has already been in successful action against the enemy is the American Grumman "G 36" single-engined naval fighter. This machine is fitted with an engine of 1300 H.P. and an electrically controlled Curtiss airscrew. It is stated to have a top speed of 330 miles an hour. In appearance it is somewhat unusual, but it is credited with exceptionally good handling qualities. A twin-engined version is also in production.

Employment Returns

IT was officially announced by the Ministry of Labour and National Service, on Wednesday, January 8th, that the total of unemployed persons on the register at the last count taken on December 9th, 1940, was 705,279, which is 85,901 fewer than in November and the lowest total since 1921, since which year the number of the insurable population has greatly increased. The Ministry's communication is as follows:—The number of men and boys registered at employment exchanges in Great Britain as wholly unemployed at December 9th was 265,011, a decrease of 43,120 as compared with November 11th. Those registered as on short time or otherwise temporarily suspended from work on the understanding that they were shortly to return to their former employment numbered 84,850, a decrease of 11,727 as compared with November 11th. Those registered as unemployed casual workers (being persons who normally seek their livelihood by jobs of short duration) numbered 20,435, a decrease of 3113 as compared with November 11th. The corresponding figures for women and girls at December 9th were 276,889 wholly unemployed, 56,998 temporarily stopped, and 1096 unemployed casual workers. As compared with November 11th, the numbers wholly unemployed showed a decrease of 18,221, those temporarily stopped a decrease of 9789, and unemployed casual workers an increase of 69. At December 16th there were 35,508 women registered as applicants for work in districts to which they had been evacuated, a decrease of 3686 as compared with November 18th. It will be recalled that the Ministry has made an inquiry into the employability of all men who have been on the register for a month or more, the results of which inquiry were published in outline in December. It has now been decided to extend the inquiry to women workers. The table of divisional changes which was issued with the December 9th figures shows that employment increased in the London, Eastern, Southern, North Midlands, North-Eastern, North-Western, Northern, Scotland and Wales administrative divisions, and only decreased in the South-Western and Midland divisions.

A Cement Production Committee

SPEAKING in the House of Commons recently, Mr. George Hicks, the Parliamentary Secretary of the Ministry of Works and Buildings, announced that Lord Reith, the Minister of Works and Buildings, had decided to set up a committee to consider the production of cement. Its terms of reference are as follows:—"To consider and report to the Minister whether, bearing in mind the probable demands for cement in meeting current needs, and in post-war reconstruction, and taking into consideration economic, strategic, and other factors affecting the allocation of cement, new cement works should be established, existing ones extended, or old plant modernised; and, if so, what general considerations, financial, geographic and economic, should apply." The committee is formed as follows:—Mr. George Balfour, of Balfour, Beatty and Co., Ltd., Chairman; Mr. R. Bullock, a National Industrial Officer of the National Union of General and Municipal Workers; Major F. C. Cook, M. Inst. C.E., Chief Engineer of the Highways Division at the Ministry of Transport; Mr. R. Coppock, General Secretary of the National Federation of Building Trades Operatives and President of the International Federation of Building and Woodworkers; Mr. A. Deakin, Acting General Secretary of the Transport and General Workers' Union; Mr. Joseph Stanley Holmes, Vice-President of the Building Society's Association; Sir William McLintock, senior partner of Thomson, McLintock and Co., chartered accountants; Mr. George Parker, director of George Parker and Sons, Ltd., builders and contractors, and Chairman of the National Joint Council of the Building Industry; and Mr. P. E. Thomas, F.R.I.B.A., who was the President of the F.R.I.B.A. from 1935 to 1937. The Secretary of the Committee is Mr. C. I. C. Bosanquet, at Lambeth Bridge House, London, S.E.1. The Cement Production Committee held its first meeting on Tuesday last, January 14th.

The Speeding Up of Shipping at Ports

ON Saturday, January 11th, it was officially announced by the Ministry of Transport that, in order to obtain a greater co-ordination of effort at the ports, the Minister of Transport has appointed Mr. J. Gibson Jarvie, the chairman of the United Dominions Trust, Ltd., and Mr. Robert Letch, the assistant general manager of the Port of London Authority, to be Regional Port Directors for the North-Western Region and the Clyde Region, respectively. The new directors began their work on Monday last. Their functions will be to co-ordinate port activities within their region in order to secure the most rapid clearance through the ports of goods, whether inward or outward bound; the quickest turn-round of ships and the best utilisation of the port facilities. In order to achieve these ends the new directors have been authorised by the Minister to exercise the powers he has hitherto reserved to himself of issuing instructions, general or particular, to the Port Emergency Committees regarding the directions they give to the Authority at any port for regulating, facilitating and expediting the traffic. The Port Emergency Committees were set up at the principal commercial ports in the country before the war, and have been vested by the Minister with wide powers for securing the most efficient operation and the rapid clearance of goods through the port. The North-Western Region comprises all the ports between Holyhead and Silloth, and the Clyde Region all ports between Stranraer and Oban.

The Road Transport (Defence) Advisory Committee

IT will be recalled that the Road Transport (Defence) Advisory Committee was formed in 1938 for the purpose of reviewing the detailed plans which had been provisionally worked out by the Ministry of Transport for the control of the transport of goods by road in time of war and to review the position at intervals. Its main task was thus largely discharged before the outbreak of war, although it has been consulted by the Minister from time to time since. On Friday, January 10th, the Secretary to the Ministry of Transport made the following announcement as to the future work of the Committee. The recent setting up of the Road Haulage Consultative Committee, a step in which the Minister was influenced by the representations of the Road Transport (Defence) Advisory Committee, has transferred to the former body, which is directly linked with the various associations of operators, the greater proportion of the questions upon which the Minister may, from time to time, find it desirable to seek advice, and in consequence the necessity for consultation with the Road Transport (Defence) Advisory Committee will be less likely to arise in the future. The members of the Road Transport (Defence) Advisory Committee, however, have agreed to continue to hold themselves at the disposal of the Minister, so that their assistance may still be available to him should any questions arise upon which he desires to consult them.

The Air Training Corps

ON Thursday, January 9th, the Royal Air Force and the Fleet Air Arm announced that his Majesty the King has been pleased to approve the constitution of an Air Training Corps, which will be organised on a nation-wide basis. It will consist of University Air Squadrons, squadrons and flights formed at schools, and units organised locally. The new Corps will give to young men at schools and universities, and those who have left, an opportunity to prepare themselves for service either in the Royal Air Force or the Fleet Air Arm. The scheme will greatly enlarge the field of selection for these services, and candidates of the required educational standard will be able to get a grounding in service subjects before they are attested. All boys of sixteen and upward, who are physically fit and desire to serve eventually in the Royal Air Force or the Fleet Air Arm, will be eligible to join the Air Training Corps. Boys who are suitable for flying duties will carry out a syllabus like that of the Initial Training Wings of the Royal Air Force. Special courses will be arranged for those boys who are suitable for the mechanical or wireless trades. Grants to cover the cost of training will be made by the Air Ministry. The Air Training Corps will, however, depend for many of its amenities on local support. A new post of Director of Pre-entry Training at the Air Ministry has been created, and the Trustees of Uppingham School have, at the request of the Air Council, agreed to release the headmaster, Mr. John Frederick Wolfenden, to fill the post for a period of six months. The Director will be responsible to Air Marshal A. G. R. Garrod, the Air Member for Training on the Air Council. Responsibility for the training of all units and for the administration and recruitment of local units will be vested in a Commandant directly responsible to the Air Ministry. Air Commodore J. A. Chamier, who was closely associated with the development of the Air Defence Cadet Corps, is being released from his present Air Force duties to become Commandant.

British Supply Council in North America

CHANGES in the British supply organisation in North America, which have been made desirable by the great increase in supplies from Canada and the United States, were officially made known on Tuesday evening last, January 14th. A Council has been set up and is called the British Supply Council in North America. Mr. Arthur B. Purvis has been appointed Chairman and Mr. Morris Wilson the Deputy Chairman of the new Council. Sir Clive Baillieu has been appointed to succeed Mr. Purvis as Director-General of the British Purchasing Commission. The Council, it is announced, will deal with all issues of policy concerning supply, including representations to be made to the United States Administration. The members, in addition to Mr. Purvis and Mr. Morris Wilson, will be Sir Clive Baillieu, Sir Henry Self (the Director-General of the British Air Commission), and Vice-Admiral A. E. Evans (the head of the Admiralty Mission in Canada). There is to be no alteration in the relations between the Supply Departments in this country and the Department of Munitions and Supply in Canada, but in view of the close connection between the Canadian and the United States programmes, Mr. Howe, the Minister of Munitions and Supply in Canada has agreed to become a member of the British Supply Council. We may recall that Mr. Purvis has served as Director-General of the Britsh Purchasing Commission in the United States since November, 1939. Mr. Morris Wilson, who becomes the Deputy Chairman of the new Council, was for some years the President of the Royal Bank of Canada.

The Employment of Aliens

SOME time ago it was stated by Mr. Ernest Bevin, the Minister of Labour and National Service, that steps were to be taken to enrol an international labour force from the foreign population now in this country, which numbers something over 250,000, excluding children under sixteen. Among these there are 14,000 Poles, 10,000 Czechoslovaks, 4000 Norwegians, 7000 Dutch, 14,000 Belgians, and 10,000 French, while, in addition, there are about 50,000 Austrian and German refugees who can be relied upon as being friendly to this country. The work of recruiting workers from these sources has been entrusted to the International Labour Branch of the Ministry of Labour and National Service, under the direction of Major-General K. C. Appleyard. The Branch has kept in close touch with the Allied Governments, the foreign trade union organisations in this country, and the refugee organisations. It has also received the support of the British Employers' Confederation and the Trades Union General Council. Its work has included the recruitment of friendly Austrians and Germans for the Pioneer Corps, while suitable men are being drafted into industrial pursuits and into agriculture. Exact figures are not available, but it is revealed that the average number of employment permits issued to the employment exchanges for aliens has been at a rate of 3000 a month, and that the register of unemployed aliens in the London area has been halved, which brings it down to something over 5000. On the special register for skilled workers and technical men there are the names of 300 engineers of various nationalities who want employment. For the untrained workers training is to be available at Government training centres, and the policy of placing men and women as far as possible in national groups will be followed. It is provided that foreigners entering employment shall have the same wages, working, and unemployment insurance conditions as British subjects. In order to overcome any prejudice in the workshops all international workers are to be distinguished by a badge which, it is hoped, will serve as a credential and a passport.

"War Aims"

By LT.-COL. E. KITSON CLARK

"THERE must be a new world after the war," the Press says it, people say it. These constantly call for Utopia, but they do not define its conditions and they disregard its derivation. Our politico-philosophers, moreover, are insistent that we should now prescribe, not only for ourselves, but for all other nations as well. We must remind these advisers that the real folk of those nations are now dumb, perforce, and that our own mobilised millions can say nothing. Surely it is presumptuous to pronounce judgment as to what others ought to have while we do not know what they want. That is not far from a form of that dictation against which we are fighting.

Changes are necessary—so everyone agrees—changes proportionate to the great crisis which is upon us. As a prologue to some thought on the subject I may perhaps take a text from a chance conversation between myself—an engineer—and an old friend—a jobbing gardener. Both of us had seen another war and he was speaking proudly of a fine lad, his nephew, and his service. "What is he fighting for?" I asked. "For home," was the immediate reply. "Home," he said, "meant for him a happy safe life for his family and friends, constant employment and good enough wages." "And liberty?" I asked. "Oh, yes, liberty and England," he said.

This was the war aim of the soldier, and I think it would be much the same for the munition worker and for every woman. There was little ideology about the programme, except the elicited approval of liberty and the added touch of traditional patriotism that made one's heart warm. I do not know what trade the nephew followed, and first I began to think, "If he were an engineer what expectation could he have of 'constant employment' and 'good enough wages.'" This is the common denominator of everyone's wishes, and it involves the prosperity of the industry as well as of its servants. I then came to wonder if each industry could be examined by its constituents.

For the engineer there are three proposals often made. They demand careful and respectful consideration.

1. That the employees should share the profits.
2. That the employees should take part in the management.
3. That there should be no employer other than the State.

1. *The Employee Shares the Profits.*—This is the most attractive conception and has been applied generously and successfully in certain well-known industries. In engineering difficulties occur at once to one who looks back on fifty years of change in demand and fluctuation in price, involving periods of prosperity and loss.

First, as to the times of loss. The worker could not be expected to have an actual deduction from his remuneration when his firm loses. This modification breaks down the complete application of the principle, but a qualitative sharing might not necessarily put the ideal out of court. There are in engineering still more difficult problems. The length of time in the execution of most contracts and the subsequent lag in the calculation of results would dissipate the *ad hoc* interest as well as postpone the reward assignable to a man's weekly output. Again, though there would be no difficulty in accepting a professional estimate of the results upon which a share of the firm's profits might be expected, there might be in the general mind a want of confidence in the handling of the contract by the management. Moreover, in a very large and composite job one section might disbelieve in the efficiency of another.

It would seem by inference that the fairest method would be to estimate the proportion of margin which could be thought to appertain to each object as produced. Such a scheme is not far removed from the piecework system now prevalent, which bears the title "payment by results." But it does not bear a calculated relation to the eventual profits of the firm.

These comments bear only on certain classes of engineering work. There will be openings doubtless in some directions. It will not be denied, indeed, that the use of margins over and above the full cost of production requires more sympathetic consideration than has been given to it in the past. But on one thing all concerned would agree: a system should not be imposed from outside.

2. *The Employee Should Take Part in the Management.*—Each industrial establishment incorporates three essentials: property, management, labour. It is agreed that these three partners are dependent on one another and on the results of their combined action, and that makes a point in favour of this second proposal. But the protasis is not quite complete, because labour is far less anchored than the other two.

At the same time, it is clear that the theory underlying this proposal reaches out to that ideal of all our association in industry and, indeed, in national and international life—namely, confidence in one another.

The process would seem to be the selection by the employees of one of their number; for again no one would, I suppose, admit the inclusion of an outsider, except under Communism. In a firm which contains members of six different trades unions there might be difficulty, and, further, it might be found that the segregation of a representative from his colleagues would destroy the common touch and so prove an actual obstacle to mutual confidence. But let us assume a representative acceptable to all interests; what would his function be? He would be unable to accept responsibility for adventures in markets and methods, or for advance purchases and all the intricacies of these complicated entities.

There remains the adjustment of relations of management and labour, which should undoubtedly exercise the attention of both parties. First, there are the conditions in the establishment and the ventilation of grievances. Whether these can be treated better by a representative on the board elected for that purpose than by the well-known Welfare Committees is a matter of internal experiment. And next comes the remuneration. There may be a better way than the present system of examination of the controlling forces potential as well as actual, by the Federations of Employers and Trades Unions, but it has not yet been discovered. At the present time an application for consideration passes by an agreed series of conferences, works conference, local conference, central conference, national conference. The procedure is deliberate, as is fitting where large interests are involved, although on one side it seems at times too slow. Again, no outside element touches these discussions or affects their decisions, and hitherto both parties are agreed that this should be so. For the constitution was framed in 1897 and since that date the industry has been remarkably free from trouble. The terms of that constitution have developed remarkably and the relations of the two parties have grown closer and more sympathetic steadily, as I may be allowed to confirm from my own observation.

For in 1888 I entered the workshop, sharing the full hours with the men and so was admitted by them to the abrupt and kindly fellowship that we think is typical of our county. Trades unionism was not strong, the leading members seemed always to be fighting a battle and the authorities, I must confess, were bitter. But fifty-two years is a long time for improvement, and I think we all require educating towards a new understanding. It may be another story, but I am convinced that none of us was taught as we should have been in our schooldays what was meant by the spirit of service, or of duty as I should prefer to call it.

3. The third proposition has been heard on the wireless in the words "Nothing for profit, all for the common good." It is the phrase, too, of the amiable young men, who have been educated out of their parents' dividends and enjoyed the training which benevolent fortune-makers have endowed; and it is, I know, the dream of many of our splendid young defenders. And when I say "How?" I have sometimes been answered, "How do they do in Russia?" To that my only reply can be, "I don't know, but of this I am convinced, that, however wrong our system may be, however right that of Russia, the worker of Britain is happier, and always will be, than beneficiaries of those Communistic blessings." The next premiss is "Scientists, economists are daily increasing the wealth of the world by discoveries or programmes, and they derive therefrom no reward outside their professional remuneration." For these acts, which often entail personal devotion and courage, we have, and we shall always have, reason for admiration and gratitude. But as we survey the world around we know that we should not have made the material progress which we now enjoy without the achievements of the pioneers who invite adventure in the furtherance of their own personal interests.

However far, then, the system of State-owned, State-managed industries are developed on the principle of "margins to the community," let us see that there is no embargo placed on the enterprise which produces individual rewards.

We must look mainly to these experiments for material developments and for all foreign trade. The last sentence is to be emphasised. For when trade is the function of a nation, competition between nations involves dangers of international complications which lead to war.

So far an engineer's examination of his own industry may be thought to end in the disappointing verdict "As you were." But it is felt that a fair scrutiny of limitations is necessary before a scheme is accepted as a panacea. The essence of the first two propositions, "profit-sharing" and "management sharing," is to make association closer and more friendly and to ensure that the conditions, and remuneration are more satisfactory. I can bear witness that internal relations in establishments are exercising more and more the thought and goodwill of all parties and I believe in the British process of development. I have watched the growth of mutual understanding through fifty years and I think we recognise that while progress has been too slow, happily the present *tempo* is far quicker.

At the beginning of that half century the labourer's wages was 18s. for a week of fifty-three hours; now it is 57s. 6d. for a week of forty-seven, which is notable even when the reduction in the purchasing power of money is allowed for. The shops were cold and stuffy, dark and dirty; that would not be tolerated now. There was hostility for trades unions, and this has changed to a genuine respect for their good influence.

So much for the industry's internal reactions.

But the matter does not end there. This third cure of all ills is found by some in State possession and State management. I quote a recent statement:—"The primary cause of present evils is the failure of the economic system, which has become the dominant factor in modern civilisation. . . . Persons are more important than profits." I include the alliterative aphorism because the word "profit" gives a key to the thought underlying the pronouncement. But neither sentence should stand by itself. As well might one say: "Folk are more important than food." It is the undigested motto of the anti-capitalist and it is repeated and broadcast without any attempt at an honest analysis.

You have told us in your columns that the Purchaser pays. Can you open them to the arguments of skilled economists? The headings of Working Capital, Reserves for Development, Provision for Lean Years, and so on, are beyond the scope of these paragraphs. And here there is the greatest problem of all, which is a function of all the rest. How are we to answer the straightforward call of the young soldier, "constant employment"? Can a political system ensure this? Yes, a Tyranny can. Can it be done under Democratic rule? The answer has always been, "Yes, by Free Trade of the world." Frankly, this generality is not satisfactory to the man who does the work, and he cannot but ask himself, "In that day when the country that produces with least cost gains the trade, would the engineering shops of Britain be full?" "Is not the engineering capacity of the world so great that some countries would be starved of employment? And would Britain not suffer?"

For standards of living vary the labour cost, and until they are made comparable in all industrial countries Britain must look to its own interests first. Let us say this and not be afraid of patriotism. But let us put all our force of thought, of resource, of inventiveness, and above all, of the spirit of an association of workers, thinkers and payers to the service of the work which is the engineer's contribution to Britain's peace aims.

PEACE AIMS

For an epilogue I change the title. Britain has to see that her unemployment is done away with, and the miseries of her slums destroyed. And it will be the ambition of the engineer to do his part. His difficulty will be to occupy all the capacity of installation and skill which will be waiting for action. He can deal himself with the first two propositions under the headings "Share in Profits" and "Share in Management," but his outlook is now being hampered by these vague

generalities, these irresponsible promises put forward by respected authorities. Surely they do a wrong thing if they do not give their reasons, the analysis of their reasons, the basis of the analysis. We should be told exactly where the failures of the present economic system are to be identified, and what specific remedies are proposed. Can we pray that some who have wisdom and knowledge could clear the air, for us, and encourage the engineer to go about his business with a feeling of duty to his country? The issue is tremendous. Who will help?

Harbours and Waterways in 1940

No. I

OUR annual review of engineering activities of the year in connection with harbours and waterways at home and abroad has appeared in these pages at the beginning of each year for nearly fifty years with the exception of the war years 1915–1918. This long series of articles constitutes an almost continuous historical record of the development of engineering science as applied to maritime works, rivers, and canals. In this month of January, 1941, our record must of necessity be briefer than usual, and incomplete. Little can be written concerning the works that have been, and are being, carried out in British ports at home and abroad for the accommodation and service of the naval forces of the Crown, or in the way of emergency and additional accommodation in home ports necessitated by the partial diversion of sea-borne traffic from its normal routes.

It is, however, no secret that much of the normal sea-borne trade of our East Coast ports has been diverted to the West Coast, and that important works are being carried out in some of the western ports with the object of increasing as rapidly as possible their import and export capacity.

Certain ports on the West Coast of England have been called upon throughout the past year to deal with cargoes aggregating a tonnage three to four times that of a peace-time year. Statistics cannot be given at the present time; but we may be sure that, in spite of the delays and setbacks which here and there have occurred, and will occur, as the result of enemy action, the tonnage figures realised in some of the busiest of our British ports, and which may be made public when this country is at peace once more, will be interesting reading. It may be noted, in passing, that, during the last eighteen months of the war of 1914–18, the ports in Northern France operated by the British Army passed an import tonnage of well over 1 ton per day per foot of quay frontage.

Enemy action has resulted in damage being done by bombing of British port works and equipment in several localities. No details of such occurrences can be given; but we are certain that the aggregate of such damage is much less than is commonly reported by rumour and insignificant in comparison with the claims made by German propagandists and in enemy official communiqués. Most of it, excluding the relatively few dockside warehouses, storage buildings, and transit sheds that have been seriously damaged by high-explosive bombs or completely gutted by fire, is susceptible to rapid repair even if such repairs must be for the present of temporary or emergency character. These repairs have been, and are being, carried out expeditiously and the berthing and quayage space put out of action either permanently, or for a long period, is very small.

A solid concrete or masonry quay wall is not a target susceptible to heavy damage even by the detonation of a heavy bomb on or close to it. In most cases, the damage done by high-explosive bombs to such structures is superficial only and can quickly be made good. Open-work quays, especially those which are carried on unenclosed reinforced concrete and timber piles, have suffered serious damage more frequently. A bomb detonating in the water alongside a piled jetty will often result in the fracture of a number of piles; open structures carried on clusters of piles within cylinders, or on concrete-filled cylinders, have, however, proved highly resistant to bomb attack. In any case, the damage done in docks and harbours to such wharves and jetties, whether of the piled or cylinder type, has, in most instances, been quickly repaired.

Dockside cranes, dock gates, and other relatively small targets in a port area are notoriously hard to hit. It is not therefore surprising that the damage done by the enemy in the course of raids on British ports has resulted in little damage to cranes and similar equipment. We visited recently a port which two days previously had suffered a very heavy night raid, and, according to German reports, had been heavily damaged. We did not notice one of the many cranes on the dock sides which showed any appearance of having sustained a hit.

On the other hand, it is probable that, for various reasons, the damage done by our British Bomber Force in ports and on waterways in Germany and in enemy-occupied territory has been much more serious than that suffered by ourselves. Among these probable reasons are the superiority of our bomb aiming generally from aircraft flying at relatively low levels, and the larger proportion of quays and wharves in Continental ports that are carried on piled structures than in British harbours and docks. Solid quay-wall construction has been resorted to in the past in Continental ports, especially in Germany and Holland, to a much less extent than in this country. In the ports of Holland, and in many German ports, also, timber piling has been, and is still, extensively employed. Such construction is specially vulnerable to damage by incendiary bombs.

There can be no doubt that much of the damage done in enemy ports and on waterways by our Air Force is capable of emergency repair and has been so repaired. Even such damage as that resulting from the spectacular raids on the works of the Dortmund-Ems Canal can be repaired, and it has for that reason been necessary to repeat at frequent intervals the attacks delivered by our bombers on the canal works in order to extend the period during which sections of this waterway—so valuable to the enemy—are put out of operation wholly or even partially.

We have at intervals throughout the past year published accounts of some of the industrial and other targets of military importance in Germany and Italy which have been attacked by our Air Force. These articles include plans and descriptions of several of the ports and inland harbours which have already suffered heavy damage.

GREAT BRITAIN

The Port of London

Lord Ritchie, at a meeting of the Port of London Authority in April, reviewed the work and trade of the port during the past three years. He said that, with the exception of five new warehouses, all the works authorised by the Act of 1935 for the development of the Royal Victoria Dock and the improvements at the Royal Albert Dock at a cost of over 1½ million pounds had been completed. In view of the situation created by the war, the construction of all new works included in the Authority's extension scheme was suspended in October, 1939, with the exception of the warehouses at the Royal Victoria Dock, then already in hand. Under an arrangement made with the London County Council the Authority agreed to contribute to the cost of reconstruction of ten bridges involved in the Council's scheme of road improvement in the vicinity of the docks. Five of these bridges had been reconstructed at the end of the financial year and one was then nearing completion.

Southern Ports

The widening of the Itchen quays at Southampton, to which we referred a year ago, has been completed. These quays comprise the berths, known as Nos. 34, 35, and 36, south of the entrance to the Empress Dock; they have been widened by 38ft. and the depth of water alongside increased from 28ft. to 34ft. at L.W.O.S.T. To facilitate loading and discharge from and to the first floor of the transit sheds a reinforced concrete platform 20ft. wide has been constructed in front of sheds Nos. 35 and 36 at the first-floor level.

Scotland

The Greenock Harbour Trustees on April 1st closed to all traffic the well-known Princes Pier at Greenock, and in the following November invited tenders for its partial reconstruction in reinforced concrete and steel sheet piling.

On February 18th, without any of the publicity and excitement that attended the departure from the River Clyde of the "Queen Mary" in 1936, the "Queen Elizabeth" passed down the river from Clydebank and out to sea bound on her maiden trip to America in such secrecy that few of the general public other than dwellers on Clydeside heard of the voyage until after the vessel had reached New York. The careful preparations made to ensure by dredging ample depth of water and width in the river channels for the safe passage of the world's largest ship enabled the "Queen Elizabeth" to reach the Tail-of-the-Bank without any serious difficulty in a little over four hours.

EUROPEAN PORTS AND WATERWAYS

Germany

Authoritative information regarding port works now in progress in those parts of Europe in enemy occupation and in Germany is scanty. It is known, however, that dock and quay extensions and other works are being carried out at several German naval ports, including Wilhelmshaven, Kiel, and Heligoland.

Aerial photographs made by reconnaissance planes of the R.A.F. show that work is in progress on the new and larger entrance locks of the Kiel Canal approved by the German Government in February, 1939, some particulars of which we included in our Annual Review a year ago, as well as on a new and larger entrance to the closed dock at Wilhelmshaven. The entrance comprises two locks, and a new dry dock and protection mole are also under construction at the port.

The short canal link, named the Adolf Hitler Canal, between Gleiwitz and the River Oder, 25 miles long, was opened to traffic in December, 1939, and at the same time work began on the construction of the Oder–Danube Canal, which will join the Adolf Hitler Canal at Blechhammer. This waterway will be 200 miles long, its object being to connect the Rhine, the Oder, and the Danube to complete a ring of waterways linking together in the north the Rhine, Weser, Elbe, and Oder with each other, the North Sea and the Baltic, and extending to the south to the Black Sea.

Holland

Reports appearing in the enemy-controlled Press of Holland state that the Pernis oil basin on the south side of the Nieue Maas at Rotterdam is being extended. The basin was first opened in 1935 and has been enlarged since, the last extension being begun early in 1939 before the German occupation of Holland. The basin is not far from the open sea and much lower down the river than the old oil basin which was the principal centre of the oil trade in the port up to 1935. The works and storage tanks at Pernis have been heavily bombed by the R.A.F. on many occasions since the enemy occupation began.

France

The mole at La Rochelle, between La Pallice and the Ile de Ré, was opened for passenger traffic early in 1940, when a ship from Antwerp called to embark passengers for the Belgian Congo. The construction of the mole, a deep-water jetty intended mainly for passenger line traffic, was begun in 1931, but, owing to financial and other difficulties, work on it was suspended several times. Construction was finally resumed in 1937. The intention of the mole was to make La Pallice the ocean port of La Rochelle and a rival to Le Verdon, where a deep-water jetty affords accommodation near the mouth of the Gironde for ocean liners landing and embarking passengers to and from Bordeaux. A viaduct with two decks, one carrying the railway to La Rochelle and Paris, and the other a roadway and footways, connects the mole with the mainland at La Pallice. The mole itself is situated in a deep and sheltered channel accessible to vessels of deep draught at all states of the tide.

Little is known in this country of the activities of the Vichy Government in planning public works development in unoccupied France; indeed, the future of the overseas trade of France cannot at present be foreseen. However, Monsieur Bertholet, the Minister of Communications, announced in October that further improvements to the port of Marseilles, estimated to cost 420 millions of francs, were envisaged. These works, he said, would equip that port, within five years, to handle

the entire shipping of the French Empire, amounting to a total of 25 million tons annually.

Russia

It was reported in the Soviet Press early in the year that work had been commenced on the construction of the Dniepr-Niemen waterway, 315 miles long, which is to link up the River Yaselda, a tributary of the Pripet, with the River Shchar, a tributary of the Niemen. Through the Rivers Niemen and Dniepr this new waterway will link up the Baltic and the Black Seas, passing through the provinces of Baranovichi, Pinsk, and Belostok. The scheme entails the building of thirty locks.

The Press service of the U.S.S.R. has also announced the opening to navigation in the course

SINKING SCREW PILE AT BEIRA

of the summer of 1940 of the Dniepr–Bug Canal, which links the Dniepr, one of the largest rivers in European Russia, with the Western Bug. The canal, which is 126 miles long, provides an outlet to the Black Sea for the industrial and agricultural products of Western Belorussia.

AFRICA

Cape Town

The pressing need of dry-docking facilities for large vessels in Table Bay was emphasised in October, when the liner "Ceramic," *en route* to Australia, and the freighter "Testbank" were brought to Cape Town for repair after collision. The "Ceramic" cannot be permanently repaired in South Africa owing to the lack of a dry dock sufficiently large to take the vessel. Consequently, temporary repairs only, sufficient to enable the ship to proceed to an overseas repair port better provided in this respect, can be effected at Cape Town.

War conditions do not appear to have had the effect of slowing down the work of extending and improving the harbours of the Union of South Africa undertaken by the Government. In fact, the expansion of the shipping trade of the Union, consequent on the war, has stimulated activity on the extension works already in hand and hastened preparations for beginning others, including the long-desired large dry dock in Table Bay on the Woodstock side of the new harbour. The present programme of the Union Government provides for the expenditure of over 8½ million pounds on the principal harbours.

At Cape Town the foreshore reclamation in the enlarged harbour area has been begun and a commencement has been made with the building of the quay along the seaward frontage of the reclaimed land. Over one-half of the first section of this quay, which, when completed, will be about 4000ft. long, has now been built by the Railway and Harbours Administration employing direct labour.

The first main contract for the harbour extension works at Cape Town, comprising about one-half of the whole project, is expected to be completed about the end of 1941 by the Dutch contractors to whom the work was entrusted in 1937. These contractors, the Hollandsche Aanneming Maatschappij, have recently been given additional contracts, including one for the cofferdamming and part filling of the area inside the new mole upon which the new dry dock 1200ft. long is to be built.

Work on the second half of the great Table Bay harbour project, the cost of which, when it is completed, will considerably exceed 6 million pounds, has not yet begun. It comprises, among other works, about 6000ft. of deep-water quay wall.

Other South African Ports

At Port Elizabeth the No. 1 quay in the inner harbour has been completed and the new berths for oil tankers are now in use. The extension by 1000ft. of the south breakwater at East London has been completed at a cost of over £219,000, and work is now proceeding on the extension of the turning basin and the construction of additional quayage and transit sheds.

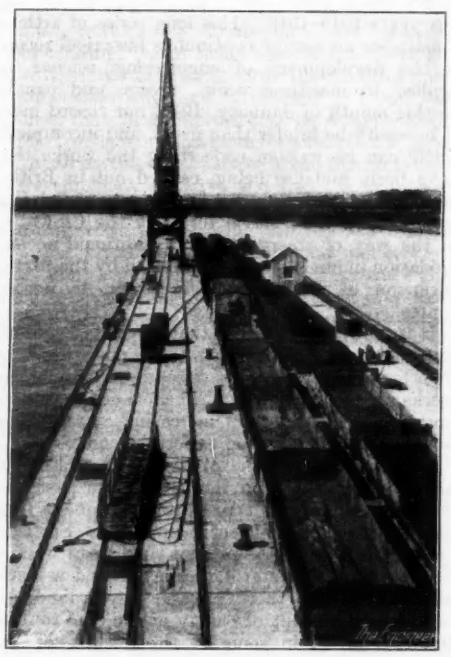
At Durban additional deep-water berths are being made, a new marine airport is under construction, and the elimination of the cant at the outer end of the north pier, mentioned in our Annual Review of the year 1939, has made good progress. This work, when it is completed, is expected to improve greatly the entrance to the harbour of Durban which, at its narrowest point, is no more than 600ft. in width. Large additions have been made to the equipment of quayside cranes in the port and a new cargo shed has been brought into service during the year. The Maydon channel in the harbour is now being deepened by dredging from 30ft. to 35ft. The scheme of harbour improvements at Durban approved by the Union Government calls for an expenditure of about 2¼ million pounds.

Beira

The whole of the new berths and jetties comprised in the extension works undertaken by Beira Works, Ltd., in 1937, have now been completed and are in use, including the fifth deep-water berth, additional transit shed accommodation, and the reclamation of land behind the wharves. The works have been carried out by the contractors, Pauling and Co., Ltd., under the direction of Messrs. C. S. Meik and Halcrow, of Westminster. The dredging of the new channel across the Portilla Bar and the deepening of the existing entrance channels begun in 1939 are still in progress. The new channel, when completed, will be known as the Carmorra channel and is named after the President of the Portuguese Republic, who visited Beira in 1939. The new and existing entrance channels are being deepened sufficiently to permit vessels drawing 28ft. of water to enter the port at high water of any tide. The depth alongside the wharves is 27ft. at L.W.O.S.T., but all of them have been constructed to allow of the depth being increased to 33ft. when required. We published in our issue of May 3rd, 1940, an illustrated account of the new harbour works at Beira.

North Africa

In recent years the French Government had been actively engaged in the development of the ports in Northern and Western Africa, and, up to the date of the French collapse, work was in progress on the naval base and harbour at Mers-el-Kebir, near Oran, which had been considerably accelerated since war began. At that



NEW QUAY AT BEIRA

time Oran had become the strongest naval base on the North African coast. The development of the port of Dakar, which, like Oran, was the scene of regrettable, though necessary, action by the British Navy in the course of the summer, was also being pressed forward with much activity up to the time of the French surrender to Germany.

(To be continued)

Shipbuilding and Marine Engineering in 1940

No. II

(Continued from page 16, January 3rd)

THE conditions under which we are called upon to write this article do not permit us to describe in detail many of the more interesting ships which during the past year have been completed and have entered service. In what follows we refer, however, to some aspects of the shipbuilding and marine engineering industry which are important and will be of interest to our readers.

Destruction of Shipping by Enemy Action

Some anxiety has been felt in the last few months at the rate of destruction of British and Allied merchant shipping through enemy action, and our capacity to replace it. The accompanying diagram shows the tonnage of mercantile shipping sunk by Germany since the beginning of the war. Shortly before the end of the year, writing in the *Burntisland Shipyard Journal*, Mr. Wilfred Ayre, the chairman and managing director of the Burntisland Shipbuilding Company, Ltd., gave an interesting analysis of the position. It has been stated, he said, that in the first year of the war 396 ships, totalling 1,561,000 gross tons, had been sunk, making an average of 30,000 tons per week. Allied and neutral shipping also suffered heavily, and in the same period those losses were about 363 ships, of 1,300,000 gross tons. The enemy loss by capture, scuttling, and sinking was approximately 330 ships, of 1,300,000 gross tons, making a world total of all nationalities of ships lost through war operations of about 1089 vessels, of 4,161,000 gross tons. With an allowance for natural obsolescence and for enemy ships now operating under the British flag, a total world casualty figure of round about 4,000,000 tons can be assumed. With the increased submarine and aircraft activity of the last few months, the rate of sinking of British ships has risen to an average of nearly double that recorded for the first year of the war. New measures are being taken to reduce this loss, which showed a decided drop in November and December. Should they be effective, after making allowances for natural losses through marine perils and obsolescence, the total should, Mr. Ayre says, be well within the capacity of our shipyards to make good. Even so, there is every need to maintain and exceed the present output of the shipbuilding industry, and no opportunity should

be lost to secure more tonnage from any source available, and to increase the shipbuilding programmes in the Dominions and America.

British and American Shipbuilding Programmes

In our last article we referred to the new mercantile ships now being constructed in Great Britain and America. In the main, these are comparatively small ships of under 10,000 tons with a designed sea speed of about 10 knots. They are being equipped with Scotch boilers and steam reciprocating machinery, the installations being kept as simple as possible. By this means rapid production is ensured. In addition, there

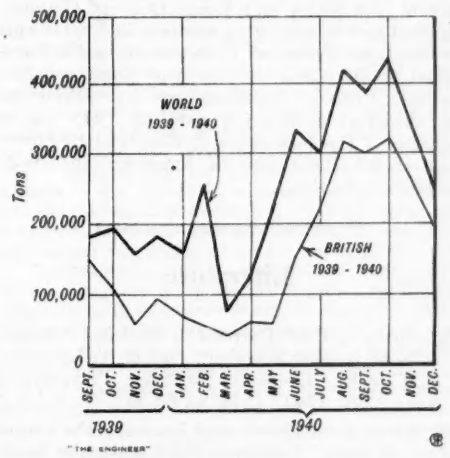


DIAGRAM OF TONNAGE LOSSES

are a series of larger ships with steam turbine machinery and water-tube boilers which take longer to complete. Against this programme that of the United States forms an interesting contrast. Apart from the building of a further 200 mercantile ships recently announced by President Roosevelt, there were under construction in American shipyards no less than 128 cargo ships, of which about 13 are completed and 115 approaching completion or in course of construction. Of these 86 are turbine-driven ships with water-tube boilers and 42 are fitted with direct drive or geared oil engines. The speeds are as follows :—52 ships, 16½ knots; 39 ships, 15½ knots; and 37 ships, 14 knots. Not a single ship, we may remark, is to be fitted with Scotch boilers and reciprocating engines. All the turbine-driven steamers are equipped with water-tube boilers, either of the Babcock or Foster Wheeler type, the working pressures being mainly 450 lb. per square inch, with a final superheated temperature of 750 deg. Fah. In addition, there are 33 tankers, of which a few months ago 11 were completed and 22 under construction. Of these, 26 are to have geared turbines with water-tube boilers, and 7 will be motor driven. Of the turbine-driven ships, 14 will have a sea speed of 16 knots, and 12 a speed of 13 knots. Three of the motor tankers are to have a speed of 13 knots and 4 a speed of 12 knots. In addition to the ships above mentioned, there are others such as steam tugs and ferries.

In the United States the programme includes the outputs of large electrical firms such as Westinghouse and the General Electric Company, which are constructing marine turbines alongside industrial types. With the much-needed expansion of our shipbuilding and marine engineering programme, would it not be possible, it may be asked, to broaden the basis of marine production in a similar way?

Mechanical Stoking at Sea

The operation of ships off their normal schedules, often under convoy conditions, has emphasised the value of mechanical stoking and its attendant good combustion control. In striking contrast to hand firing, especially with Scotch boilers, often with inexperienced stokers and inferior fuels, stoker-fired ships have shown their ability steadily to maintain full power even with low-grade fuels, with a complete absence of smoke. Many of these ships are operating on routes far from those for which they were designed, and have shown excellent results with a wide variety of fuels.

The third ship of the "Amra" class which was referred to in our last year's review has the same type of propelling machinery. The boiler equipment comprises three standard Babcock marine boilers with a total heating surface of 17,895 square feet, 3345 square feet of superheater surface, and 14,400 square feet of tubular air heating surface. The boilers operate at a pressure of 450 lb. per square inch, and the steam is superheated to 750 deg. Fah. They are equipped with Babcock-Erith retort type stokers, with enclosed ash-quenching arrangements, while coal and clinker crushers form part of the stokehold equipment. The steam drums of the boilers are of Babcock fusion-welded construction.

An interesting ship completed abroad in 1940 was the steamer "Karuah," built for the Newcastle and Hunter River Steam Ship Company, of New South Wales, by the Hong Kong Whampoa Dock Company. In design she follows her predecessor the "Mulubima," and is fitted with two standard Babcock marine boilers with superheaters and Babcock-Erith retort type mechanical stokers.

Another coal-fired ship equipped with mechanical stokers was the "Invicta," designed and built for the Dover and Calais cross-Channel service of the Southern Railway Company by William Denny and Brothers, Ltd., of Dumbarton. She has an overall length of 350ft., a beam of about 52ft., and in her normal service is designed to carry about 1300 passengers. Her propelling machinery comprises a twin-screw arrangement of Parsons single-reduction geared turbines taking steam from two large Yarrow water-tube boilers fitted with Taylor marine type stokers. The boilers were built to Yarrow designs at Dumbarton, and the stokers were supplied by the Taylor Stoker Company. The boilers have a designed output of 70,000 lb. to 80,000 lb. of steam from feed at 220 deg. Fah. to saturated steam at a working pressure of 250 lb. per square inch. The boilers incorporate Taylor metal block covering on the furnace side of the tubes, and slag drip construction above the block-covered, water-wall surface. A closed stokehold has been adopted with a forced draught system. The stokers are electrically driven. The "Invicta's" normal service demands unusual operating conditions. About 10,000 S.H.P. must be released within a few minutes of the order for starting being given, and on arrival at the other side of the Channel the power must be similarly rapidly reduced. The bunkers are of such a size that the ship can be operated for about a week without having to refuel.

Oil-fired Boilers

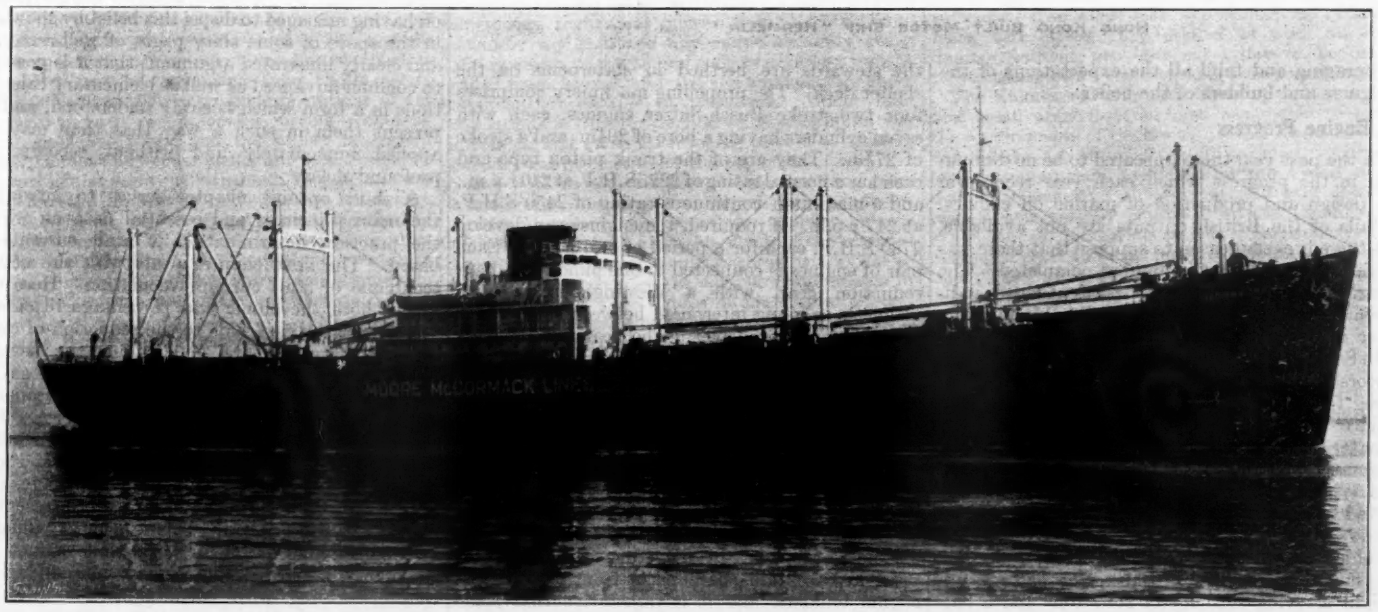
In last week's article we referred to the fine performance of the Yarrow boilers in the Cunard liner "Queen Elizabeth," which made a record Atlantic crossing without previous trials. The ship has now been reported at Cape Town, which she reached *viâ* Trinidad. The success and reliability of these boilers is a tribute to Yarrow design.

The past year saw progress made in oil burning in marine boilers, both for naval and mercantile work, and for large powers. Some of the large liners described in last week's article formed outstanding examples of such work. Much of the work included Admiralty three-drum designs, and in the Babcock-Wilcox works these have been fitted for the first time with Babcock fusion-welded steam and water drums.

In Holland, two fast passenger and mail turbo-electric steamers built by the Netherland Shipbuilding Company of Amsterdam, for eastern service in the U.S.S.R., were completed and were handed to their owners before enemy occupation. The boiler equipment of these two ships, the "Joseph Stalin" and the "Viaschelav Molotov," consists of four standard Babcock marine boilers with a total boiler heating surface of 23,430 square feet, 4044 square feet of superheater surface, and 21,080 square feet of tubular air-heater surface. The boilers are designed to operate at a working pressure of 455 lb., superheated to 700 deg. Fah. Standard Babcock oil-burning equipment is fitted.

Further ships built in Holland which were fitted with Babcock boilers were the "Saidja" and the "Saroena," built by the Rotterdam Drydock Company for the service of the Anglo-Saxon Petroleum Company. These steam-driven tankers were completed in the early part of 1940. The boilers consist of two standard Babcock units having a total heating surface of 10,640 square feet, and 6400 square feet of tubular air-heater surface.

During the year technical advances were made both in connection with the Babcock-Johnson and the standard Babcock designs. In the case of the Babcock-Johnson boilers the new design effects further reductions in size and weight,

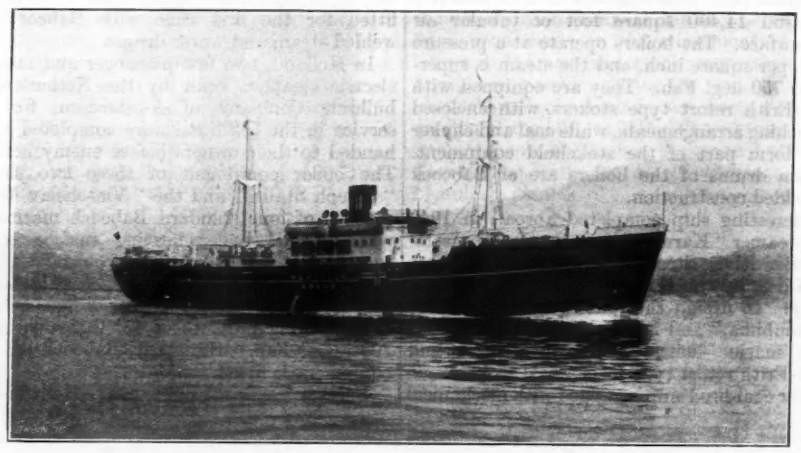


UNITED STATES MOTOR SHIP "MORMACPENN"

while in connection with the standard design a new simplified single-pass boiler for small powers has been produced. Owing to the nature of the applications of these boilers it is not possible to publish details of these new developments at this juncture.

In last year's annual review we illustrated the Foster Wheeler "D" type water-tube boilers installed in the United States liner "Challenge." Following the visit of that ship to these shores, and the great success which has attended the adoption on a large scale of the Foster Wheeler boiler in America, considerable interest has been taken in this special design, which is particularly suitable for cargo vessels, both coal burning and oil burning. During the past year many shipowners, anticipating the day when they will be able to build modern steamers, have had designs prepared for both coal-burning and oil-burning installations. The most modern design, we are informed, is particularly suitable for cases in which the highest fuel economy is desired, and includes the Foster Wheeler separately fired superheater boiler. In this design absolute control of superheater is, it is claimed, obtained, which renders it possible to build boilers for the highest degree of superheat associated with very high pressures.

The Howden-Johnson boiler is being applied to a few of the smaller naval craft, and the total number of these compact boiler units now at sea in other vessels is considerable. The reports received from shipowners are, we are informed, very encouraging and fulfil all the expectations of the designers and builders of the boiler.



HONG KONG BUILT MOTOR SHIP "HERMELIN"

Oil Engine Progress

In the past year there appeared to be no diminution in the progress which each year records in the design and production of marine oil engines. Details of the British outputs are not available, but there is every reason to suppose that there was no falling behind in the number completed. The returns from the Continent, particularly Scandinavia, show that the motorship still holds a leading place in the programmes of foreign shipowners.

In September last we gave a short account of the motorship "Hermelin," which was built in Hong Kong for the China Coast and Far Eastern port service of the Norwegian owners, Bruusgaard Kioaterud, of Drammen, Norway. The ship was designed, built and engined by the Hong Kong and Whampoa Dock Company, Ltd., and is illustrated herewith. Her principal dimensions are as follows:—Length overall, 291ft. 2in.; breadth moulded, 43ft.; depth to shelter deck, 25ft. 6in.; measurement, 1603 gross tons. She has a deadweight carrying capacity of 2607 tons and a bale carrying capacity of 167,500 cubic feet, with a contract speed of 12 knots. The propelling machinery, which was also constructed in the builder's yard, comprises a five-cylinder, two-stroke reversing engine of Harland-B. and W. design, having uniflow scavenge with exhaust poppet valves. The designed output of the engine is 1390 to 1700 S.H.P. when running at 130 to 160 r.p.m. respectively. The cylinders have a bore of 500 mm. with a stroke of 900 mm. Most of the auxiliary machinery is of British manufacture and it includes a Paxman-Ricardo oil engine-driven Reavell air compressor, Lee-Howl circulating salt and fresh water pumps and other pumps by the Mirrlees Watson Company, Ltd., and the Albany Engineering Company, Ltd. The power for driving the auxiliaries is developed by three Allen three-cylinder oil engines coupled to 70-kW generators. Successful trials were run in ballast condition over the Hong Kong measured mile and a mean speed of 13·65 knots was recorded at an engine speed of 148 r.p.m. The loaded contract speed of the vessel is 12 knots. In addition to the well-designed cargo-carrying facilities, the "Hermelin" has excellent accommodation for ten passengers in five two-berth staterooms.

In our first article we referred to the use of geared oil engine propelling machinery in the programme of ship construction laid down by the United States Maritime Commission. In an accompanying engraving we illustrate the cargo liner "Mormacpenn," which is the first of these geared oil engine ships to enter service. She was built by the Sun Shipbuilding Company, of Chester, Pa., and is one of the first "C-3" cargo ships to be completed. Her principal dimensions are:—Length, overall, 492ft.; breadth moulded, 69ft. 6in.; depth to shelter deck, 42ft. 6in.; full-load speed, 16½ knots. Her deadweight carrying capacity is 11,735 tons, with a bale capacity of 684,000 cubic feet. There are five cargo holds, three forward and two aft of the machinery spaces. As will be seen from our illustration, there are five pairs of Samson posts, which are served by twenty 5-ton booms for cargo working, and one 30-ton boom for heavy lifts. The Samson posts also serve as ventilators for the cargo holds. The deck house amidships contains the accommodation for the officers and crew and the deck and engine-room staffs; the stewards are berthed in staterooms on the shelter deck. The propelling machinery comprises four two-stroke Busch-Sulzer engines, each with seven cylinders having a bore of 20½in. and a stroke of 27½in. They are of the trunk piston type and each has a normal rating of 2225 S.H.P. at 240 r.p.m., and a maximum continuous rating of 2450 S.H.P. at 247 r.p.m. If required, the engines can develop 2780 S.H.P. each for a period of two hours. Each pair of engines is connected to one pinion of a Falk reduction gear, with a Westinghouse electromagnetic coupling interposed between each engine and the pinion it drives. The gear ratio is such that at the normal speed of 240 r.p.m. the propeller speed is 85 r.p.m. The control gear is so arranged that all the engines can be manœuvred together or operated separately.

Spare Parts for Foreign-built Oil Engines

During the past year a question which exercised the minds of many British shipowners was the securing of spare parts for marine oil engines built on the Continent. In numerous cases it is not possible to obtain spare parts from the original engine builders, and it is imperative that some provision should be made for the supply of such parts from suitable British firms. Assisted by the Admiralty and the Ministry of Shipping, some agents for foreign-built engines have been able to build up a supply of spares, made in this country, but the position is one which now requires immediate attention if the necessary supply of spare parts is to be ensured for British-owned ships having foreign-built engines, and those ships of other nations which have been chartered for British service. Apart from the pressing need of keeping ships at sea, the addition to our export trade which would follow a well-organised spare part service is not one which should be overlooked.

An event of historical interest in 1940 was the celebration of the centenary of William Doxford and Sons, Ltd., of Sunderland.

Obituary

PROFESSOR DAVID ROBERTSON

WE greatly regret to learn of the death, on January 8th, of Dr. David Robertson, Professor of Electrical Engineering at Bristol University. Professor Robertson was born in December, 1875. His preliminary education was received at Helensburgh and his technical education at Glasgow Technical College. In 1899 he graduated B.Sc. at Glasgow University with special distinction in electrical subjects. His works training was received in the shops of James White, Ltd.—now Kelvin, Bottomley and Baird, Ltd.—of Glasgow. In 1900 he was appointed Lecturer in Engineering at Bradford Technical College and in 1902 was called to the Chair of Electrical Engineering at Bristol. Professor Robertson was a prolific writer on electrical engineering subjects. He was a member of the Institution of Electrical Engineers and of the Institution of Engineers and Shipbuilders in Scotland.

Literature

Calculation of Fault Currents in Electrical Networks (Circuit Breaker Selection). By R. T. LYTHALL, A.M.I.E.E. London: Sir Isaac Pitman and Sons, Ltd. 1940. Price 8s. 6d. net.

MR. LYTHALL is already well known as the author of the *J. and P. Switchgear Book*, a popular handbook on switchgear engineering practice, which made a welcome reappearance some time ago after a lapse of many years. In this new book he deals with an aspect of the subject which is of immediate practical interest, namely, the technique of choosing circuit breakers and associated apparatus correctly, in relation to the fault current to be expected, at any point in a power network.

While the importance of making such a choice is by now widely appreciated, and not only so in connection with the national "grid" system and its many "selected" generating stations of large installed capacity, but also in regard to the smaller sub-stations and their pendant distribution systems, there seems to have grown up alongside this appreciation a general belief that the calculation of fault currents in power networks is a highly specialist art calling for extensive mathematical attainments. Mr. Lythall is to be congratulated on having managed to dispel this belief by showing, in the space of some sixty pages of well-reasoned and clearly illustrated argument, that it is possible to conduct advanced as well as elementary calculations in a form which is easily understood, and to present them in such a way that they may be applied immediately and without recourse to profound theory.

A short opening chapter serves to introduce the main principles and essential data on which the practical determination of fault currents is based. The next chapter deals with the actual technique of fault current calculation. Here the use of both the ohmic and percentage reactance methods is outlined, aids to the reduction of complicated networks are given, and the several formulæ for calculating symmetrical and asymmetrical short-circuit currents, both instantaneous and delayed, are presented in handy form. The third chapter is devoted entirely to elementary examples of calculation, which are worked out in the greatest detail, yet in simple language, and in such a way as to bring out clearly all the essential features of the method. This is a most valuable and painstaking piece of work that cannot be too highly praised. Then comes a more advanced chapter dealing with calculations for different points and conditions on a quite complex interconnected system, each separate calculation being in the form of a series of network reduction diagrams. The last chapter discusses the application of the foregoing technique to low-voltage networks, where the values of short-circuit current are influenced by the equivalent reactance of the high-voltage network constituting the source of fault kVA. The book concludes with a number of appendices giving useful data in tabular form, followed by a short bibliography of selected references.

We have only two criticisms to make. One is that, in an up-to-date book on this subject, the author could, with advantage, have adopted the per unit system of calculation which avoids the constantly recurring factor 100 that is the bugbear

of all calculations involving percentages. The other is that a couple of chapters on the principles and methods of calculating unsymmetrical faults would have made the book an even more useful work of reference. For the application as distinct from the theory of symmetrical components lends itself to that simple and straightforward interpretation which is the outstanding feature of Mr. Lythall's work. As it is, this is a book which ought to find a place on every electrical engineer's bookshelf.

SHORT NOTICES

Bibliography of Spectrochemical Analysis. Compiled by D. M. Smith, A.R.C.S., B.Sc., D.I.C., F. Inst. P. Second edition. The British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1. Price 3s., post free.—Mr. Smith's book, "Metallurgical Analysis by the Spectrograph," was published in 1933, and included a list of 114 references. This list, brought up to March, 1935, was then issued as a separate publication, under the title "Bibliography of Literature on Spectrum Analysis." In the present second edition of the bibliography, the references have been brought up to August, 1940, and now number 510; to conform with current terminology the title has been changed to "Bibliography of Spectrochemical Analysis." Short explanatory notes are given with most of the references, and an author index is provided. The grouping of the references in sections obviates the necessity for a subject index. There have been some alterations to the arrangement of the matter, possibly the most important of which is the inclusion of a new section on "Applications of the Microphotometer," a subject of particular importance at the present time. As before, references are given under the headings of the individual basis metals (with cross references), so that the reader may quickly find all the published information dealing with his particular field of interest. The section headings are: Books of Reference; Wavelength Tables; General; Apparatus; Technique; Logarithmic Sector Method; Applications of the Microphotometer; Quantitative Interpretation of Spectra; Analysis of Metals and Alloys (including Aluminium, Copper, Lead, Magnesium, Nickel, Tin, Zinc, Iron, and Steel, &c.).

South African Engineering Notes

(By our South African Correspondent)

Rhodesia's Demand for Electricity

THE number of mining concerns which depend on the Rhodesian Electricity Supply Commission for electric power increased in the past year by 128 properties to a present total of 327, and the aggregate consumption was more than doubled in the twelve months, advancing from 23,714,000 to 52,955,000 units. The large-scale operations of the Commission have revolutionised mining economies in the past five years, and the supply of current to every mine of any consequence and to the majority of farms in the colony is visualised, though the war has deferred a number of contemplated extensions. The Commission, whose capital expenditure in five years has exceeded £1,000,000, and which supplies all the municipalities and important townships with the exception of Salisbury and Bulawayo, employs a European staff of 146 and 1300 natives.

Sabie Hydro-electric Generating Plant

The Sabie power station in the Transvaal is the only hydro-electric generating plant owned by the Union Electricity Supply Commission, and is consequently of considerable interest. The whole of the output of the station is supplied to two gold mining companies operating in the district, and so far there are no signs of any other mines starting. Electricity sent out from the station in 1939 amounted to 6,757,600 units, a decrease of 11·9 per cent. The maximum half-hourly demand was 1225 kW and the load factor was 74·85 per cent. Total working costs increased from £13,311 in 1938 to £13,707 in 1939. Revenue for the year amounted to £13,457. The average price per unit sold increased from 0·441d. in 1938 to 0·506d. in 1939 as a result of increased working costs and decreased consumption.

Use of Producer Gas

An arrangement under which many heavy commercial and farming vehicles will run on producer gas instead of petrol is envisaged in the first interim report of the Producer Gas Commission. The Committee was appointed by the Union Director-General of War Supplies last May "to investigate the use of producer gas as a substitute fuel for petrol vehicles and also to make recommendations for the manufacture of vehicular gas producers." The Committee has found that producer gas is a practical substitute for petrol, and the only one of immediate importance to the Union, and that there is enough surplus hardwood available to meet the fuel demand for 20,000 producer-gas-driven vehicles, while there are alternative indigenous fuels. The immediate production of 5000 gas producer units would be justified, they conclude, as a precautionary measure against the dislocation to be feared in the event of a petrol famine. They point out that the use of producer gas would entail the modification of petrol engines and would mean reduced speed and payload capacity and additional labour. On the other hand, it is declared by those competent to judge that on balance the economy obtained makes it well worth while to convert a petrol lorry or tractor to producer gas, provided that the work expected of the vehicle justifies the additional capital outlay.

A ¾-ton lorry running on producer gas has done 100 miles at a fuel cost of 2s. 4d. A 4-ton lorry used a bag of charcoal (2s. 6d.) for 60 miles, while on petrol at 1s. 11d. a gallon the minimum cost would have been 14s. 5d. A tractor could plough 2 morgan (about 2¼ acres) at a cost of 1s. against 20s. running on power paraffin. The Committee find that the use of gas means a saving of 70 to 80 per cent. in the fuel bill, and that this is enough to make conversion of vehicles economical provided the vehicles cover a minimum mileage of 6000 or 7000 a year. Many of the measures which must be taken for the production of national requirements under war conditions are perforce uneconomic, or, at least, sub-economic, they say. It is gratifying therefore to envisage a potential war supplies undertaking which does not necessarily fall into this category.

It is submitted that a fair proportion of the transport requirements of the Union can be converted from an imported fuel basis to an indigenous one, and this conversion may well remain economical even under peace conditions. Furthermore, if the movement can have as its foundation an easily grown forestry product, in the production of which a large proportion of farmers in the Union can participate, it has an obvious advantage in the national economy. In an addendum to the report the Committee states that the 5000 units they suggest would require 250,000 tons of hardwood a year for fuel, leaving a surplus of 750,000 tons. In the improbable event of this surplus being absorbed, or if the demand for producer gas units increased beyond 20,000, additional fuel could be obtained by increasing afforestation or using other solid fuel.

South Africa Plans for War Period

South Africa is mobilising her resources to help win the war. The great international struggle will be won in the workshops and factories of the United Kingdom, the Dominions, and the United States. In Great Britain radical steps were early taken to mobilise the industrial resources of the country and South Africa, in the earliest days of the war, provided herself with powers differing little from those taken in Britain. Under the first emergency regulations power was taken to commandeer any land and any materials. Any owner of any means of production such as a factory may be called upon to make for the Government any goods his plant is capable of producing. Under later regulations a Director-General of War Supplies was appointed and given far-reaching powers to organise industry for production of the essentials of war.

But it is widely recognised that something more is needed than the direction of South African industry for the immediate purpose of war supplies. South Africa not only has to provide much of the material directly needed for prosecuting a war, it also has to maintain its output of the normal requirements of its population. Bare figures of imports or exports give little, if any, clue to the position; but it is obvious that the character of South Africa's overseas trade may be radically altered in many respects by the war. Goods previously bought from overseas may rise sharply in price—although there is little sign of such as yet. Some goods may be unobtainable. Other goods will continue to be imported from overseas sources, but from different overseas sources. Not only will South Africa's trade with overseas proceed along new channels, but equally will that of the neighbouring territories.

This development will have an enormous effect on South Africa's industrial structure. Opportunities for the expansion of existing industries and the inauguration of new enterprises may be many. That is realised by most. What is not so clearly seen is that while many opportunities will present themselves, just as many difficulties—serious difficulties—will arise. The task of mobilising the country's resources to meet present and future needs is beset with many pitfalls, but it was early tackled boldly by the Government.

First and foremost among the measures taken is the formation of a great finance company, the Industrial Development Corporation. In any developing industrial country opportunity after opportunity is often lost because capital is not available to finance promising propositions. It is to overcome this obstacle that the Industrial Development Corporation, with an initial capital of £5,000,000, has been formed. The provision of capital by the Corporation is direct assistance of outstanding importance; the effect it may have in promoting public investment is incalculable. The average investor cannot have detailed knowledge of industrial possibilities, and this is one of the reasons that he has preferred mining ventures. There are recognised experts who can assess the prospects of a gold mine. There have been no industrial experts to give an authoritative opinion on the prospects of industrial concerns. The South African investor has had to rely on his own judgment on a proposition about which he understands little or nothing, and so he has usually preferred to let industrials alone.

One of the undoubted effects of the Industrial Development Corporation will be to provide a basis for public confidence in industrial schemes. The fact that the Corporation are prepared to invest a considerable sum of money in any venture will be a warranty to the public. Side by side with the formation of the Industrial Development Corporation has proceeded another move of outstanding importance.

The Industrial and Agricultural Requirements Commission has been at work for months investigating the Union's position in relation to essential requirements for industry and agriculture. The objects of the Commission have been summed up by the chairman as follows:—"Increased war activity on the part of Britain and other nations," he said, "might be exceedingly embarrassing to South Africa. We are considerably dependent on overseas supplies of raw materials and finished products, and the preoccupation of the belligerents and other countries might seriously restrict the supplies available to South Africa. The Commission's objectives are to pave the way for uninterrupted supplies to industry and agriculture."

Union's War Production

Thousands of mechanical transport vehicles of all kinds are now being produced in the Union to equip South Africa's great Army in the north. They include many types of vehicles hitherto unseen in this country. Among them are armoured cars, troop carriers, general service wagons, staff cars for use as caravans, workshops and power units on wheels, light aid delivery vans, mobile water tanks, water tank trailers, water-purification plants, and petrol tankers. The construction of refrigeration plants on wheels is now being investigated. The bodies of all these vehicles are of steel, all of which is made in South Africa. Six months ago practically no drawings of any of these vehicles existed in the country. To-day the whole output has been standardised; thousands are already in service in the front line, and many more thousands are in process of production. Some insight into the magnitude of the task of production and the astonishing efforts to meet the situation by employers and employees in the engineering industry, particularly in Johannesburg, have been given recently by the Director of Mechanical Production: "In one private firm it would seem," he said, "that the employees are of opinion that working six days a week is not sufficient. The whole staff approached the management and stated they desired to work all day Sunday without pay—the extra day to be interpreted as their own contribution to the war effort."

The Union's war effort has already resulted in the new small arms factories now being able to meet the requirements of the South African Army. Shells and bombs are supplied in all varieties. Aircraft and armoured cars assembled in the Union show daily increases, and an army of well over 100,000 men is now entirely equipped by the Union. An expansion of industrial activity, particularly the making of parts and machinery, is now under preparation. The Buying Commission at present in America is selecting machinery with a view to making parts which had been imported.

The Rand's Arms Factories

The Prime Minister of the Union, General J. C. Smuts, on November 29th witnessed the vast range and steadily accelerating volume of the Union's industrial war effort when he visited the Rand's arms factories. General Smuts saw huge new premises now accommodating rank upon rank of enormous lathes, drills, presses and punches for mass production. In one he saw the "Cofac" howitzer, every part of which, including its carriage, its elevating and traversing gears, its heavy barrels and rifling, and its sights, is being produced locally and in steadily increasing volume. This weapon—built with a precision which is a credit to the Rand's engineers and its industrial workers—is a product of the Central Ordnance Factories. It is the only monobloc howitzer gun of this particular size in manufacture anywhere.

Besides the Cofac gun, General Smuts was shown everything that the Rand makes for war, including armoured cars, bombs, instruments, "tin" helmets, lorries, mobile canteens, trench mortars, barrels and machine gun parts, and a host of other war necessaries in factories which are still growing. The whole of the plant and building for the production of the Cofac gun was planned, designed, and built in South Africa. Only nine weeks elapsed from the time the draughtsman first put pencil to the design until the first gun barrel went through the plant. In record time, also, was the feat of bringing into existence the new heat-treatment plant for gun barrels performed.

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With the object of conserving paper the number of copies of the Index to Volume CLXX will be limited. Copies will be sent to all Institutions and Public Libraries on our mailing list, and subscribers may obtain copies on application gratis and post free.

AFTER THE WAR

AMONGST engineers Lieut.-Colonel Kitson Clark holds an unchallenged position as a speaker and as a literary stylist. Beside these engaging qualities he enjoys a long experience of workmen and of works management and direction. Furthermore, he is a very human person with wide sympathies, extended to all classes of his fellowmen. For these reasons we count ourselves fortunate to be able to print to-day an article from him on a subject which calls for delicate and circumspect handling. There is now general agreement that when reorganisation takes place after the war some modification of the *ante-bellum* relationship between workpeople and the industries in which they are engaged is inevitable. The problems that are certain to arise lie on the threshold of politics and past experience leads to the conclusion that they will become planks in party platforms unless some means of avoiding that deplorable happening can be found. We are just as certain that the majority of the workpeople in the engineering industries would prefer that the problems should be solved without the intervention of Parliament, as we are that governmental interference with their affairs would be obnoxious to employers. Can the machinations of those whose bent of mind impels them towards the political arena be circumvented? Can means be found by which the aspirations of the workers may be satisfied whilst the best characteristics of the engineering industries are retained? On the answer to that question peace in the industry depends. It should be sought at once. We know not when peace, with its thousand difficulties, may descend upon us. May it not find engineers wholly unprepared.

Colonel Kitson Clark selects for consideration "three proposals often made." They are that employees should share profits, that they should take part in the management, and that there should be no employer but the State. The last of these three things lies wholly in the political field; it is across the threshold. It affects not only the engineering industry, but every industry in the land. If it be adopted as a political principle there will be no contracting out of it. Engineering like every other industry will be caught in its toils. It lies outside our province and it would be improper for us to discuss it. But the two other subjects are not of the same kind. There is no reason why they should be subject to a national decision; no reason, at present, why the engineering industries should not come to an independent arrangement about them; no reason why they should become political at all. Colonel Kitson Clark shows us the spirit in which they might be approached by both sides—the spirit of reasonableness. They require to be discussed without heat, and, above all, without prejudice. They will never be settled if, on the one hand, we have recalcitrant employers who will not even listen to arguments with which they are not in agreement, and, on the other, workmen who have been taught to regard the employer as their natural foe. The case for and against them must be put in calmness and settled by logical discussion. Colonel Kitson Clark shows in his all-too-brief discussion the obstacles that lie in the way of the realisation of both of them. We suggest that his arguments should be fully developed by a competent body of engineers and that an equally competent body of workmen should reply to it. That should be done in writing, for, in the preliminary stages, at least, the dangers of rhetoric must be avoided. The written word is always calmer and more carefully weighed than the spoken word. It is less likely to generate heat; it puts greater restraint on passions. Although on the *a priori* evidence it may seem that neither of the proposals is practicable, it would be wrong to conclude that no practicable scheme could be evolved. Colonel Kitson Clark indicates, very sympathetically, the difficulties; the protaganists of the changes may see a way of circumventing those difficulties. If, and we recognise the significance of that little word, the right atmosphere could be maintained in the discussion then it should be possible to reach a conclusion, on purely rational considerations, that neither plan was possible, or that one or both of them could be adopted with advantage. Colonel Kitson Clark tells us that he has watched through fifty years the growth of mutual understanding between employer and employed. Is it too much to hope that that mutual understanding has now reached a point at which such problems as "share in profits" and "share in management" could be settled by agreement?

If we put aside the animus against all who enjoy greater power than themselves, it seems probable that one of the principal factors, if not the sole factor, in all schemes for a new industrial system is the very natural desire of the workmen for security of employment during the years of his working life. The enormous difficulties that stand in the way of the realisation of that desire are patent to all who have given it consideration. It will be the ambition of the engineer, as Colonel Kitson Clark says very rightly in his Epilogue, to do his part in solving this tremendous problem. "But," our author continues, "his outlook is now being hampered by these vague generalities, these irresponsible promises, put forward by respected authorities." Engineering employers cannot fail to recognise the great danger that lies in these "vague generalisations" and "irresponsible promises." It may not be the appropriate time to make a considered reply to them, but surely the reply in as far as the engineering industry is affected should be given earnest consideration *now* so that it may be ready for use when the need for it comes.

Radio in Wartime

RADIO as a weapon of war would have seemed a strange and unattractive idea to the brilliant band of pioneers who first conceived the possibility of radio signalling through space. But during the interval between the two Great Wars men's minds speculated much as to the position radio might be expected to take in war time. Broadcasting apart, opportunities hitherto unapproached were plainly offered for communicating with any agents who might be engaged in collecting information in countries other than their own; though there was, it seemed, the chance that Powers engaged in hostilities might endeavour to close all routes by a universal jamming of every possible wavelength. Any such scheme as this last would, in so far as it succeeded, suffer from the serious disadvantage of precluding the Power responsible from itself using those channels of communication for its own purposes, whether for broadcasting to its own people or to foreign countries, and not least for espionage. But because of the great ease with which the source of such messages could be traced by the modern highly efficient methods of radio direction-finding at short range, the risk of leaving the channels open was not very serious so far as anything of the nature of spying was concerned; of this a striking instance has lately been seen in this country—with results forbidding to any further such efforts.

These are far from being the only ways in which one can envisage the use of radio in war time, but this is not the time for any general discussion in public. As is well known, there have been inventors who have announced wide claims for a radiation so powerful as not merely to put out of commission most internal combustion engines, whether in aeroplanes or tanks—a sufficiently familiar story—but even of destroying both the aircraft, the tanks and the men inside them! Some day there may be such things, but that time seems far distant. At the moment even the lesser task of cutting engines out of action is impracticable, since the screening of ignition leads prevents such interference. The guiding of aeroplanes by radio is manifestly possible, since, as is well known, it can be effectively used for manœuvring such an entirely unmanned aircraft as the familiar "Queen Bee," which for years has been in common use as a gunnery target. In the case of piloted aircraft in which the human hand can take direct charge of the more difficult tasks of taking off and landing, it can obviously be employed with even greater facility, though, once the presence of a pilot is provided, radio is best confined to more restricted tasks.

With the amazing degree of precision now possible in the design and construction of electrical instruments, it might be thought that radio direction-finding should be capable of an equal degree of accuracy, but this is not found to be the case. Radio waves of normal wavelength have the property of being reflected strongly from the ionosphere—a part of the atmosphere a hundred miles or so above us and hitherto unvisited by man. But ionospheric reflection is rarely mirror-like, unless one includes the familiar "distorting mirror," and the radio direction-finding instruments, however accurate they may prove to be in ascertaining the precise direction from which a ray arrives, cannot tell one the true direction of the source itself unless at least the tilt of the ionospheric mirror is known, which it never is. The direct ray is free from this particular ambiguity, though it has some different ones of its own, but since the radiation as received is very commonly a mixture of the two, some uncertainty as to the true direction of the transmitting station may well arise. The published results of experimental work show that it is seldom that such measurements can give a result closer than several degrees either way; for a range of 150 miles one

may perhaps expect an uncertainty of plus or minus 5 miles as the probable error. When a cut from two such stations is used, even though they be separated by the ideal angle of 90 deg., only a quarter of the positions so plotted would be likely to lie within 25 square miles. Hence plotting by this means for bomb dropping purposes is bound to be most inaccurate. Moreover, there is likely to be counter action from the targets attacked and with the modern ingenious radio methods of reprisal and protection, even this low degree of accuracy is unlikely to be attained. In fact, there is to-day little to be gained by radio assistance in actually hitting any specific target which cannot be seen and recognised by the human eye, which remains the best of all radio receivers once the target is illuminated, however feebly and indirectly, by that greatest of radio transmitters the sun.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

TOWN'S GAS FUEL FOR PETROL ENGINES

SIR,—In answer to "Inquirer's" letter in this week's ENGINEER, January 3rd, 1941, I should like to point out that I thought it would be very obvious to him that the maximum power that could be obtained from a gas engine would occur if the whole of the air was consumed and the whole of the gas. Therefore, from a theoretical point of view, the maximum power would be obtained with a theoretically correct mixture.

With regard to the test recorded in the "Proceedings" of the Institution of Civil Engineers, Vol. CLXII, "Inquirer" has missed two very important points: (*a*) that the theoretical mixture strength for town's gas used in the above test is 5·12 to 1 (for composition of gas see "Proceedings" of Institution of Civil Engineers, Vol. CLXIII, 1904–5, Part IV); (*b*) that the mixture ratio used was not 8·6 to 1, as the volumetric efficiency of the engine must be taken into consideration, and if we assume this to be 85 per cent. (it would probably be lower) we get an effective volume of $\frac{1413 \cdot 7}{100} \times 85 = 1202$ cubic inches. Therefore the mixture strength would be 7·17 to 1, or 40 per cent. excess air.

The theoretical mixture strength of average present day town's gas, 450 B.Th.U. per cubic foot net C.V., is 4·060 to 1 (see "Technical Data on Fuel," page 235, British National Committee, World Power Conference), and if we refer to the "National" high-compression gas engine, which I stated had a mixture strength of 5·7 to 1, we find that the excess air is also 40 per cent. This is, of course, purely a coincidence and could be varied with a different type of engine.

I should also like to correct "Inquirer" when he states that the mixture strength of 5·7 to 1 on the "National" high-compression engine was for maximum power. This is not so, as the engine is tuned up for maximum economy.

J. JONES, A.M.I.M.E.,
Chief Engineer.

The National Gas and Oil Engine Co., Ltd.,
Ashton-under-Lyne, January 6th.

FINANCE OF AMERICAN RAILROADS

SIR,—In the article dealing with the fine Chicago and N.W. 4–6–4 express engines (THE ENGINEER, November 8th, 1940), I mentioned that many American railways were in the hands of receivers, including the Chicago and N.W., and that, paradoxically, it was because of this, and by means of the resulting State aid, that the building of super-trains and locomotives was alone possible. Further, it was suggested that the U.S.A. had apparently gone a considerable way towards the nationalisation of railways—which, by the way, I have thought for some years to be inevitable out here. In case English readers may have assumed that my statements were careless, or at least exaggerated, I should like first to reaffirm them as being to the best of my knowledge correct, and then to give the following quotation from an article in the latest issue of the Philadelphia *Saturday Evening Post*, written by a well-known American authority, Samuel Lubell. He is dealing with the Reconstruction Finance Corporation, the Government Department set up by the U.S. Treasury a few years ago, I think at President Roosevelt's direction, to rescue corporations and enterprises that had been forced to the wall by the financial crash, but which, being valuable or indispensable, it was good policy to save.

Quoting: "... Under a court decision, when a railroad goes broke, R.F.C. claims are frozen along with those of other creditors until the reorganisation is worked out. Seventeen roads to which the R.F.C. lent money are in receivership. Two of these roads are on the verge of coming out, and they may be taken as indications of the new partnership between Government and railroads that seems in the offing. (One is) the Chicago and Eastern Illinois ... (the other is) the Chicago and N.W., where the R.F.C.'s original loan was 42,000,000 dollars, interest excluded."

Though this quotation does not, of course, prove my statements to be correct, it does reinforce them and shows they are probably founded on fact.

EDWARD H. LIVESAY.

Victoria, B.C., Canada,
December 9th.

CONCRETE FOR BUILDING

SIR,—In view of the large amount of used bricks resulting from bomb damage, it is important to examine the specifications which rule the practice in the use of concrete for building purposes. Many of the established specifications provide for only a limited range of choice amongst natural stones and do not offer the alternative of broken brick,

Any good type of brick, when broken and properly sized, makes an excellent aggregate for concrete, and if the details of the specifications are amended, after proper examination of a range of samples made up with brick aggregate, it will furnish an important outlet for much material which is lying at hand and, unless used, will cost much money for final disposal.

For any type of brick which is found to yield a crushing strength appreciably lower than required by a standard specification, the increase in thickness required, either for plain walling or many applications of reinforced work, is not likely to approach in cost that of newly quarried aggregate.

The possibilities in the use of brick in place of stone merits the attention of those institutions responsible for the standard specifications and the Building Research Laboratory.

A. LINDSAY FORSTER,
M.I. Mech., M.I.E.E.

Glasgow, January 6th.

A LITTLE SUM IN BOMBS

SIR,—A few weeks ago, December 13th, you were good enough to find room for a "Little Sum in Bombs," in which I endeavoured to show that the general belief and the German claims for number and weight of bombs dropped on English cities were exaggerated. In support of the "Little Sum" I note that it has been officially stated that in the great Manchester raid 288 H.E. bombs were dropped —probably, allowing for a few extra big fellows, 35 to 40 tons.

SCEPTIC.

January 8th.

ECONOMIC PRODUCTION

SIR,—As I am interested in the reference to the draughtsman in Mr. Tandy's article on "Other Factors of Economic Production," in the January 10th issue of THE ENGINEER, I would like, through your columns, to remind Mr. Tandy that the draughtsman commences with nothing to help him except his imagination, experience, a clean sheet of paper and his faithful instruments.

It is necessary for him to have a knowledge of a number of sciences met with in his work, understand the compositions and uses of various metals (not forgetting their cost), the intricacies met with in pattern shop and foundry, and to keep abreast with modern machine shop methods, together with the appeasement of the production and planning departments.

The interpretation of customers' specification is not the least of one of his duties, and last, but not least, it is an accepted fact that his work will be workable and efficient when completed.

Although I agree the greater the tolerance the better, I would have expected Mr. Tandy to have been aware of the modern machine shop capabilities, where, with the scientifically designed machines, the three-thousandths tolerance is as cheap and as easy to produce as the ten-thousandths tolerance referred to.

In conclusion, it should be remembered that it is the draughtsman's "pigeon" if the equipment does not work, and that it is more easy for the production people to criticise when they have the article before them than it is for the draughtsman when he has to visualise it in his own mind.

In my experience, helpful criticisms in the drawing stages are welcomed by the draughtsman, but not when the equipment has already been made and offers a good excuse on the part of the production people for late deliveries.

L. P. LOCKWOOD.

Oxford, January 11th.

Sixty Years Ago

WILLIAM MCNAUGHT

IN our issue of January 21st, 1881, we recorded the death at Manchester on January 8th of William McNaught in his sixty-eighth year. He was born at Paisley in 1813. In 1820 he removed with his parents to Glasgow, where he received a good education. Desiring to follow his father's calling—that of an engineer—he was apprenticed at the age of fourteen to Robert Napier at the Vulcan Works, Washington Street, Glasgow. He worked diligently at his trade during the day and in the evenings attended the science classes at the Andersonian College. As soon as he finished his apprenticeship at the age of nineteen, he was offered the charge of the Fort-Gloster Mills on the Hooghly. He accepted the offer, but his health suffered under the Indian climate, and in 1836 he returned to his native country. His father, John McNaught, had some years previously invented the revolving cylinder attachment for the steam engine indicator which replaced the reciprocating frame carrying the card in the Watt indicator. The manufacture of this indicator was carried on at works in Robertson Street, Glasgow, and at these works William joined his father in business. At that time Glasgow was extensively engaged in cotton manufacture. The engine generally employed at the mills was of the single-cylinder, condensing, beam class, working at a boiler pressure rarely exceeding 7 lb. Constant additions to the number of spindles and looms demanded more power, and in the efforts made to attain it serious breakdown was inevitable. William McNaught was consulted by the manufacturers on the subject. His solution consisted of the provision of a second cylinder situated midway between the crankshaft and the main centre, this auxiliary cylinder taking steam exhausted from the first. The earliest engine to be "McNaughted" was one at the Barrowfield Cotton Mills, Glasgow. The saving of fuel and other advantages which attended the conversion brought the system quickly into high favour, so much so that in 1849 William McNaught had to remove his headquarters to Manchester in order to be conveniently situated for the execution of the numerous orders which he received from Lancashire. There he remained until his death, thirty-two years later. We also recorded that he was the originator of the insurance of steam engines and was one of the promoters of the Boiler Insurance and Steam Power Company which was formed in 1859.

SWINDON

IT was, says the *Great Western Railway Magazine*, a few months more than a century ago—on October 6th, 1840, to be precise—that the directors of the Great Western Railway resolved "That the Company's principal Locomotive Station and Repairing Shops be established at or near the junction with the Great Western Union Railway at Swindon." That resolution was the result of a carefully considered report made by Gooch to his chief, Brunel, on September 13th, 1840, in which he gave sound and convincing reasons for his choice of site.

Brunel decided to discuss Gooch's recommendation on the site, and it is an unauthenticated, but quite understandable story that the Chief Engineer and his young "Superintendent of Locomotive Engines" made something of an outing of the occasion. They are said to have lunched in the open fields near the spot where the Cheltenham line was to join the Great Western below the little Wiltshire market town on the hill. Brunel appears to have been impressed with points which had influenced Gooch's selection and to have fully concurred. In fixing the exact location they decided to throw a stone, or maybe a sandwich, from where they were lunching, and where it should fall to drive in a peg, marking the site of the future locomotive depôt. This method of arriving at a decision hardly savours of the precision of a Brunel or a Gooch, but it can pass as a story. After all, these very human young men (their united ages were about fifty-eight), after disposing of their main problem and their lunch, may well have agreed to mark their decision in the boylike way recorded.

The recommendation for the provision of a central locomotive depôt at Swindon was duly confirmed by the directors at their meeting on February 25th, 1841, when it was decided "to provide an engine establishment commensurate with the wants of the Company, where a change of engines may be advantageously made and the trains stopped for the passengers taking refreshment. . . ." No mention was made of an intention to build new locomotives, and apparently the policy of having engines built by contractors to Great Western design was then regarded as quite satisfactory.

Electrical Engineering in 1940

No. III

(*Continued from page 29, January 10th*)

Automatic Voltage Regulators

AUTOMATIC voltage regulators are installed in transmission and distribution circuits and also in individual load circuits in order to control variations in the voltage applied to the load. In performing this function it is frequently desirable that voltage variations shall be corrected as quickly as possible and a regulator which operated instantaneously would be ideal. This, however, has not hitherto been possible, as in practice automatic operation is obtained by means of a voltage sensitive relay which controls a contactor and auxiliary relays, which, in turn, start up the motor operating the regulator. Moreover, in some cases the regulator itself is not suitable for frequent operation.

A new construction was recently designed and patented by Ferranti, Ltd., for greatly increasing the speed of operation of the moving coil voltage regulator so as to approach more nearly to the ideal instantaneous control. By suitable choice of gearing and size of motor any desired high speed of operation can be obtained. However, if the speed is too high the regulator will correct the voltage in a shorter time than the voltage relay takes to reset. There is then a danger that

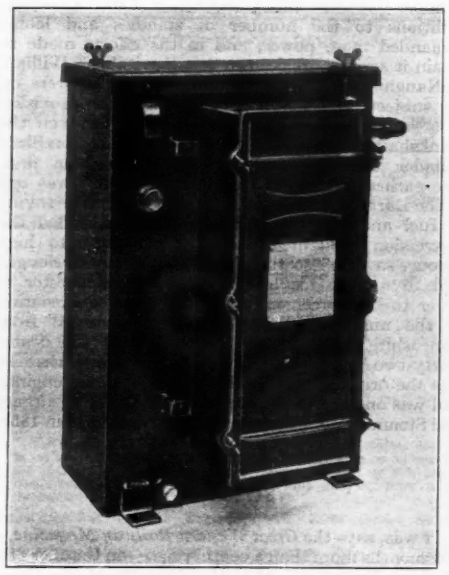


FIG. 13—HIGH-SPEED MOVING COIL VOLTAGE REGULATOR—FERRANTI

the regulator will overrun and change the voltage beyond the normal controlled value before the relay resets and stops the motor. Under these conditions the relay will then operate in the reverse direction, the cycle will be repeated, and the regulator will hunt continuously. It has been found possible to overcome these difficulties and greatly to increase the operating speed of automatic voltage regulators without any risk of hunting or instability. As an illustration, a large number of voltage regulators have been built in which a sudden change of 4 per cent. in voltage due to switching on or off of load is automatically corrected in less than 0·65 sec. Fig. 13 illustrates a high-speed moving coil voltage regulator of this type.

Investigations were carried out in connection with response contact loading and other features of automatic voltage regulators by the B.T.H. Company, Ltd., and although the benefits of those investigations can only be proved by prolonged commercial service, real progress, it is believed, has been made towards the solution of a somewhat complicated problem. Experiments are being continued with a view to improving and simplifying the quiescent type of voltage regulator, and very satisfactory results have already been obtained. During the year an interesting type of automatic load-control equipment was placed in service at a colliery. The generating plant at this colliery runs in parallel with an incoming supply, and the automatic load-control equipment is arranged to maintain the demand from the incoming supply within certain limits which can be predetermined by an adjustment of the control relays. The value of such an equipment where outside power is purchased on a maximum demand tariff need not be emphasised.

Mercury Arc Rectifiers

A large number of water-cooled rectifiers were completed by the B.T.H. Company, Ltd., during the year. Included were some heavy-current rectifiers of specially high efficiency, suitable for grid control, and rectifiers for broadcasting service at various voltages between 10,000 and 15,000 D.C., with a totally static system of grid control of voltage, and arranged for smooth automatic restoration of voltage in the event of a fault. These rectifiers are of new design and incorporate numerous improvements. Rectifiers are in hand for the Electricity Supply Commission for a section of the South African Railways, which are equipped with grid control for inverted operation, compounding, and arc suppression. They are similar to the twenty rectifiers furnished a few years ago for the main line electrification of the largest system in the world operating with inverted rectifiers and are similarly rated, namely, 1667 kW forward, or 1000 kW inverted, at 3000 volts D.C. During the year the Electricity Supply Commission also placed an order with the B.T.H. Company for three 2500-kW, 3000-volt rectifiers (with grids for arc suppression only) for further extensions of the electrified railway system, the supply to which is already mainly furnished by B.T.H. rectifiers.

Much development work was also carried out during the year on pumpless rectifiers which are now available for ratings up to 500 kW per tank at 600 volts D.C., and for all voltages up to 3000 D.C., with or without grid control. A large number of B.T.H. pumpless rectifiers were in hand for railway service, including one sub-station which will be the largest pumpless rectifier sub-station in existence.

Among the many orders received for glass bulb rectifiers during the year was one for two additional equipments, rated at 1000 kW, 230 volts, 4350 amperes D.C., for a manufacturer who already has one similar equipment in operation. The two new sets will operate in a special sub-station built with a low roof and no windows; all the cooling air required will be drawn through a light trap on one side of the building and expelled from the other side by four fans having a total capacity of 40,000 cubic feet of air per minute. Development work included the production of a grid-controlled bulb for high voltages. Satisfactory tests were carried out up to 120 kW, 12,000 volts D.C., and it is expected that there will be a demand for this bulb for high-tension supply to radio transmitter valves.

Air raids established the fact that glass bulb rectifiers possess remarkable power of resistance to blast, &c. If a bomb explodes near a sub-station without wrecking it, damage may be caused by blast, ground shock, or flying fragments. It has been found that a B.T.H. bulb will withstand at least twice the pressure which would demolish an 18in. wall and therefore offers considerable resistance to blast; ground shock which might seriously affect heavy plant has little effect on the glass bulb, due to its lightness and flexible mounting; flying fragments, of course, will damage any bulb they hit, but it is unlikely that all the bulbs of an equipment will be damaged in this way, and the station would continue to run at reduced capacity for the short time necessary to replace the damaged bulbs. These conclusions were borne out in several cases where bombs exploded outside sub-stations without any damage being done to the glass bulb rectifiers.

Research into the physical problems which are encountered in rectifier design and manufacture was undertaken by the English Electric Company, Ltd., during the year, and to carry out that research a special rectifier was constructed to permit of a wide range of experimental investigations.

Industrial Plant

Orders were received during 1940 by the Metropolitan-Vickers Electrical Company, Ltd., for main electrical equipment for mill drives of a total capacity above 23,500 H.P. continuous rating and a peak capacity of 63,300 H.P. In connection with these drives numerous steel works' mill motors were supplied, both A.C. and D.C. types, but with the D.C. type again predominating. At one plant, for which two reversing non-ferrous mills are on order, each drive is by a 300 H.P. reversing A.C. induction motor. In this

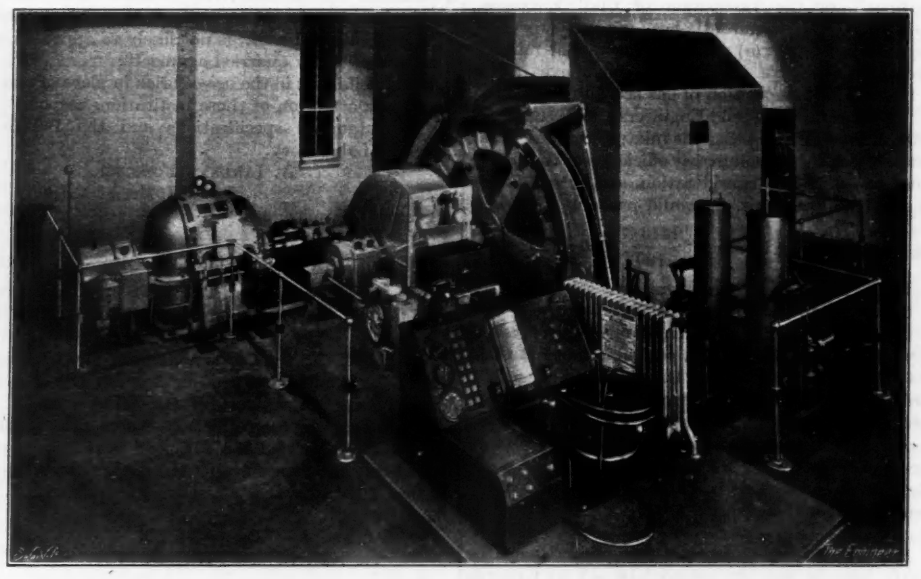


FIG. 14—A.C. WINDER INSTALLATION—METROVICK

case one of the mills is to be entirely automatic in operation. The slab is deposited on the mill table, and when the operator presses the "start" button the mill accelerates for the first pass and then it is held on the back table whilst the screw-down operates. This action, when completed, initiates the second pass, and so on until the final pass (there may be nine passes in all), when the slab is left on the run-out table to be removed by operating the inching push-button control of the motor operating that table. In the meantime, the screw-down limit switch has reset itself to the roll-opening set for pass one, and on the "automatic start" push-button being pressed the mill is set in operation for rolling the next slab. The setting of the screw-down limit switch can be modified for the various requirements at the will of the operator. Provision is made for emergency stopping of the mill and subsequent correct sequence of operations. The second mill is at present hand operated, but provision is made so that the automatic feature can be added at a later date.

Non-ferrous strip mill equipment is that of two complete mills, each of which consists of three stands which may be worked individually or together. Each stand is driven by a 100 H.P., 900 r.p.m., 300-volt D.C. shunt motor controlled by a separate 85-kW, 300-volt D.C. generator.

Of the larger equipments ordered for non-ferrous mills one is for a 780 mm. reversing breaking-down

mill driven by a 1350/3150 H.P., 40/51 r.p.m., 450-volt D.C. motor and supplied from a fly-wheel motor generator set consisting of a 1200-kW D.C. generator driven by a 1000 H.P. induction motor coupled to a 7½-ton fly-wheel. Among the ferrous mills, a 28in. cogging mill equipment for alloy steels was ordered having a mill motor of 3000/10,000 H.P., 0/55/120 r.p.m., 800 volts, supplied from a fly-wheel motor generator set consisting of 2000 H.P., 6600 volts, induction motor driving two 1200-kW D.C. generators and a fly-wheel of 150,000 horse-power seconds. In conjunction with this plant electrical equipment was ordered for a 12in. merchant mill. The motor for this mill is 750 H.P., 500/1000 r.p.m., 500 volts, and is geared to the mill. The motor is supplied through a rotary converter.

Among the tube mill equipments supplied, one of special interest is that required to drive a push-bench equipment with a reversing motor rated 700/1800 H.P., 300/450 r.p.m., 500 volts D.C., supplied from a motor generator set consisting of 560-kW, 500 volts D.C. generator driven by a 820 H.P. (715-kVA, 0·9 P.F.) synchronous induction motor, 5500 volts, three-phase, supplied through a Scott connected transformer from 7000 volts, two-phase supply.

Among orders received during the year by the B.T.H. Company was one for a complete rod mill equipment comprising a D.C. motor rated at 1250 H.P., and two rated 850 H.P., all running at 325/650 r.p.m. and supplied from a 2000-kW rotary converter. Another order covered a 1500 H.P., 214 r.p.m., slip-ring induction motor for driving an aluminium cold rolling mill. Frequent starting, stopping, and "plugging" of this motor are arranged for by the use of complete contactor control equipment—including high-tension reversing contactors for the stator circuit similar to those commonly used in electric winder service. To work in conjunction with this motor a coiler drive has been ordered, consisting of a D.C. 100 H.P. motor with control equipment arranged to start and stop approximately in synchronism with the main induction motor. From India an order was received for the drive of a 28in. three-high billet mill, comprising a 2500 H.P., 750 r.p.m. slip-ring induction motor with control gear.

Rolling mill equipments put into service during the year included two reversing mill equipments, each comprising a D.C. reversing motor rated at 1350 H.P., 40/51 r.p.m., with a peak rating of 3900 H.P., and receiving its supply from a fly-wheel motor generator set; the latter consists of a 1000 H.P. slip-ring induction motor, a D.C. 1190-kW generator, and a fly-wheel having stored energy of 50,000 H.P. seconds. The installation also includes all the auxiliary motors and control gear for the reversing mill.

The year was notable to the Metrovick Company for the number of heavy spare parts which were supplied for existing mine winder motors and motor generator sets, the necessity for making the utmost provision for continuity of operation being responsible. Orders received from abroad included a 2400 H.P., 87 r.p.m., direct-coupled, Ward-Leonard winder for South Africa. An equalised Ward-Leonard set was being built for a colliery in New South Wales, together with a turbo-alternator set to supply the hoist and auxiliaries. The winder motor has a rating of 850/1700 H.P., and is supplied from an A.C. induction motor-driven M.G. set with electrical slip regulator. The turbo-alternator set is a 1250-kW C.M.R., 2200 volts, three-phase, 50-period, self-contained turbo set with surface condenser.

At home developments in the collieries have been largely underground extensions, although a number of winders was being installed both for coal and iron ore mining. The illustration (Fig. 14) shows a typical A.C. winder installation in this country equipped with a quick-acting compound brake and driver's control desk. The clean lay-out and arrangement of the apparatus is particularly evident. This compound brake is claimed to afford a means of obtaining a given braking effort in a shorter time with less shock and strain than is associated with other systems.

Two 150 H.P. endless haulages operating in a large Yorkshire colliery were recently completed with a hydraulic coupling in place of the normal friction clutch. A further repeat order is at present in manufacture. In conjunction with haulage control equipments a flameproof certificate was obtained covering a newly developed high-tension, three-phase fuse unit incorporated with the step-down transformer for supplying auxiliary circuits and provided with electrical interlocking with the main oil circuit breaker.

An interesting apparatus in connection with a large steam winder in the Lancashire area was commissioned during the year. The equipment supplied is designed to control automatically both throttle and brake operation in the event of the cage speed exceeding that of the predetermined winding cycle and includes separate settings for men-riding to meet the landing speed limitations imposed by the Mines Department. Normal overspeed and overwind protection is also provided.

An important order secured by the B.T.H. Company during the year was for the electrical equipment of a large double parallel drum Ward-Leonard winder for installation in South Africa. The winder is to be capable of raising a net load of 8 tons per wind from a depth of nearly 6000ft. at a speed of 3000ft. per minute. The drive is taken by two direct-coupled D.C. motors (one at each end of the drum shaft), giving a total R.M.S. output of 4380 H.P. and a peak rating of nearly 11,000 H.P. The motors are supplied from a motor generator set, running at a synchronous speed of 500 r.p.m., consisting of twin D.C. generators giving a total R.M.S. output of 3300 kW, driven by a 3600 H.P. slip-ring induction motor. The winder is operated under Ward-Leonard control arranged to incorporate the B.T.H. patented system of controlled emergency regenerative braking. Another order from South Africa covered the application of dynamic braking to an existing A.C. winder. The main principle of dynamic braking consists of disconnecting the induction motor stator from its normal supply and exciting it with D.C., whilst the rotor is connected to suitable loading resistances. With the induction motor running, the effect produced is a braking torque which depends upon the intensity of the D.C. excitation applied to the stator and the value of the resistance in the rotor circuit. For this installation a patented B.T.H. system was adopted in which an exciter driven from the winder motor shaft provides for better torque/speed characteristics, and it shows a high value of torque on what is otherwise the unstable side of these characteristics. In this particular case half the movement of the driver's brake lever will control the dynamic braking, while the other half of the movement will control the mechanical brakes in the normal way.

An order for a small winder equipment (40/80 H.P.) is of special interest because of the novel arrangement of brake application and resetting. The usual equipment consists of an emergency brake weight supported by a latch that can be released by a brake solenoid when the voltage fails, a large dashpot being necessary to reduce the shock when the weight falls. In the present case the functions of the solenoid latch, resetting gear, and dashpot are all performed by a B.T.H. thrustor directly supporting the weight. A neat mechanical lay-out is thus obtained and the operation will be quicker and smoother.

During the year two large Ward-Leonard-Ilgner winder equipments were put into commission in South Africa, and a general view of one of these winders is shown in Fig. 15. It is a double cylindro-conical drum winder, the drums being 36ft. on the large diameter. They are believed to be the largest diameter drums yet supplied for electric winders. The electrical equipments incorporate schemes of controlled emergency regenerative braking, and slip regulation by means of a commutator type slip regulator. Each motor generator set includes a 40-ton single-piece cast steel fly-wheel for equalisation purposes.

Among the many different types of rolling mill equipments which the English Electric Company had in hand are included a reversing blooming mill drive for a new mill to be installed in this country, whilst another equipment was being completed to increase the output of an existing reversing mill by the addition of a separate drive to the finishing end of an existing two-stand mill. A complete drive, including main and auxiliary equipment with the necessary switchgear, control gear, and cabling, was put into operation for driving the latest type of Morgan continuous strip and merchant bar mill. A reversing mill drive with synchronised roller table drives for non-ferrous work was put into service overseas, whilst a three-high mill drive for similar purposes, but with a two-speed motor with auxiliaries, also synchronised table drives and Ward-Leonard operation of the screw-down gear, was put into operation at home.

An automatic Ward-Leonard winding engine equipment to deal with cage winding was completed for installation in Australia. This equipment is so arranged that starting is carried out by press buttons at both top and bottom shaft landings, and stopping at correct levels is obtained by the use of cams and limit switches. At the top landing the cages are supported by removable keps. Consequently, in order to land the top cage on the keps, it has to pass the landing, stop, reverse, and ultimately come to rest on these keps. This is all carried out automatically and the cage cannot be restarted until the keps have been withdrawn.

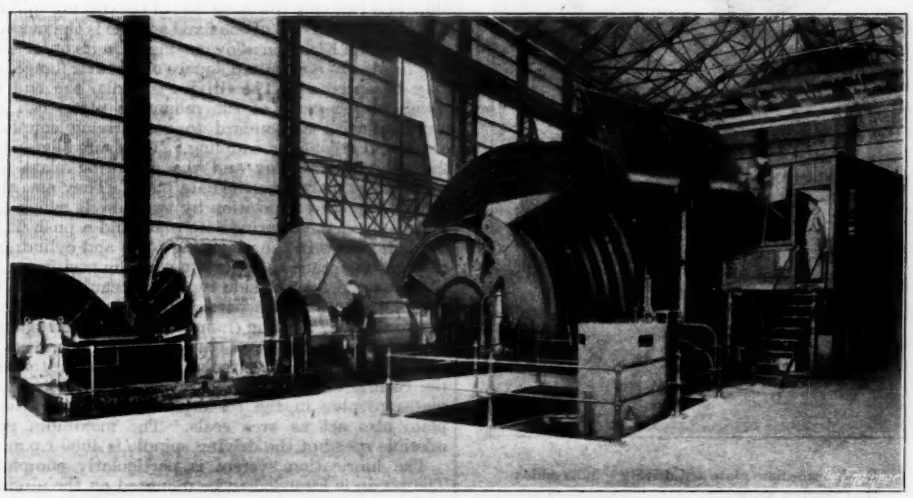


FIG. 15—ILGNER WINDER EQUIPMENT FOR SOUTH AFRICA

Mine Haulage

A large number of electrical equipments was supplied for colliery haulage ranging from 10 to 250 H.P. The development of the efficient tubular type of flameproof resistance, together with extensions to the range of flameproof cam controllers, makes it possible to use controllers and resistances up to 250 H.P., which covers most of the cases likely to be met with in the mining industry.

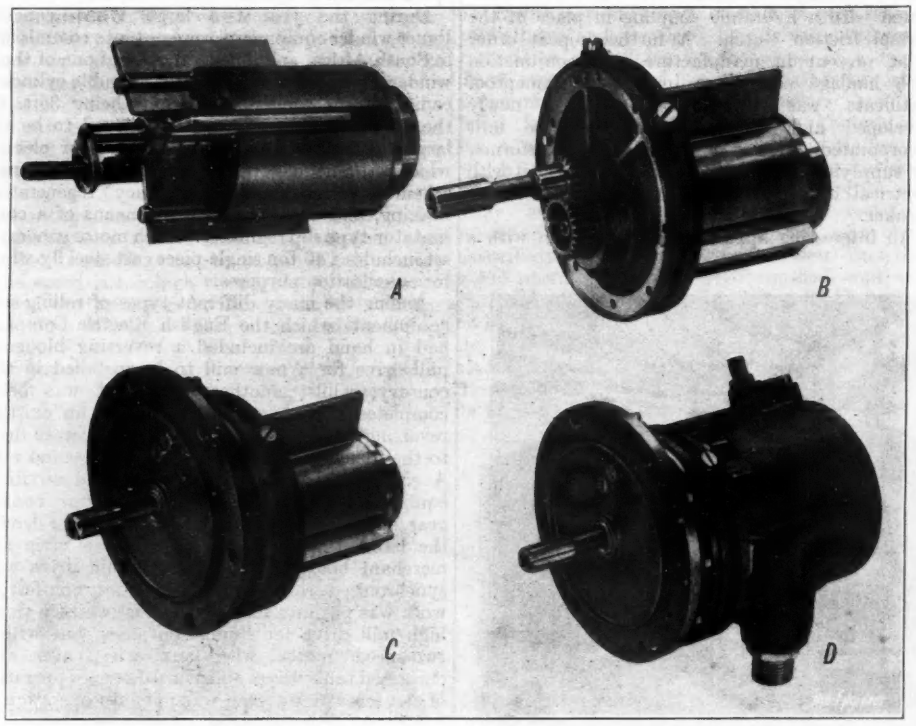
(To be continued)

RUSSIAN COAL DEPOSITS.—A Soviet newspaper reports that new coal deposits have been discovered near Leningrad. Hitherto, the lignite deposits prospected in the districts of Selizharovo, Nelidovo, and Andreapol, had been estimated to contain reserves of 500 million tons; but as a result of new prospecting in the district of Valdai the deposits are now estimated to contain 620 million tons. This year two mines will be put into operation by the Selizharovo Coal Trust.

JAMES WATT INTERNATIONAL MEDAL.—The James Watt International Medal, awarded to Professor Dr. Aurel Stodola, Hon. M.I. Mech. E., of Zürich, Switzerland, will be received by His Excellency the Swiss Minister, Monsieur Walter Thurnheer, on behalf of Professor Stodola, in the presence of the High Commissioner for Canada (Hon. Vincent Massey, M.A., LL.D., D.C.L.), a representative of the Czechoslovak Government, and other guests, at the special meeting of the Institution of Mechanical Engineers, on Friday, January 24th, at 2 p.m. The presentation will be followed by the general meeting at 2.30 p.m., and the delivery of the Thomas Lowe Gray Lecture on "Progress in Marine Engineering as Influenced by the Classification of Ships," by Dr. S. F. Dorey, Wh.Ex., M.I. Mech. E. (Member of Council).

Rotary Vacuum Pump for Aircraft

ABOUT a year ago there was concluded in our pages a series of articles dealing with the history of rotary engines and pumps. The opinion was therein expressed that modern inventors wishing to take advantage of the special properties of rotary types of design ought not to attempt the discovery of new arrangements, but ought rather to take as a basis some older design and by a study of the reasons for its earlier failures to improve upon it and rid it of its practical defects. In recent years there have been a number of examples of just such action being successfully taken. It was also pointed out in the series of articles to which we referred that a field for rotary mechanisms had been opened out by the development of aircraft, but that to succeed in that field the reliability of the machine must be undoubted, and its performance both high and well maintained over long periods. An example of a vacuum pump for aircraft instruments, the design of which is based upon a rotary first conceived early in the last century, is that described in this article. It has been developed by Fenton Smith Brothers, of Walton-on-Thames.



A—Rotor and spindle
B—Intermediate plate and driving spindle added
C—Mounting plate in position
D—Complete assembly

ROTARY VACUUM PUMP

The pump is of that type in which a drum rotating about its own axis is mounted excentrically in a cylindrical casing and carries vanes which sweep round the casing. It is, in fact, of the type which we termed " Crescent " in the series of articles mentioned above. In this case, as will be seen from the accompanying drawings and half-tone engravings, the vanes are mounted on an axle concentric with the casing, and in consequence they oscillate and slide relatively to the drum. The basic design is old and it is in the refinement of detail that the pump varies from and is an improvement upon its forerunners. Some of these details will be noticed as we describe the pump.

It is, of course, particularly desirable for aircraft purposes that light materials should be used. The casing, together with the back plate which is integral with it, is therefore a casting in Elektron alloy. The main rotor body is also made from Elektron alloy. It is machined from a cast pot and consists of four separate segments clamped between steel end plates by means of four long screws, which are countersunk in the front end plate and screwed into tapped holes in the rear end plate. The segments are held in the correct positions relatively to the steel end plates by two dowels at each end of each segment. The dowels are a force fit in the rotor segments and a push fit in the rotor end plates. In the gaps between the four segments of the rotor there work heat-treated alloy steel oscillating trunnions which have small journals at each end that oscillate in jig-drilled and jig-reamed bearings in the rotor end plates. The end plates being of harder steel than the trunnions and the trunnion steel being harder than the Elektron metal of the segments, satisfactory bearing combinations are achieved. The rotor is carried in plain bearings in the back plate and intermediate plate—see drawing. The rear rotor journal is a hollow ring integral with the rotor end plate and revolves in a bush in the casing back plate. The bush is a tight push fit in the back plate, and is held in position by four set screws.

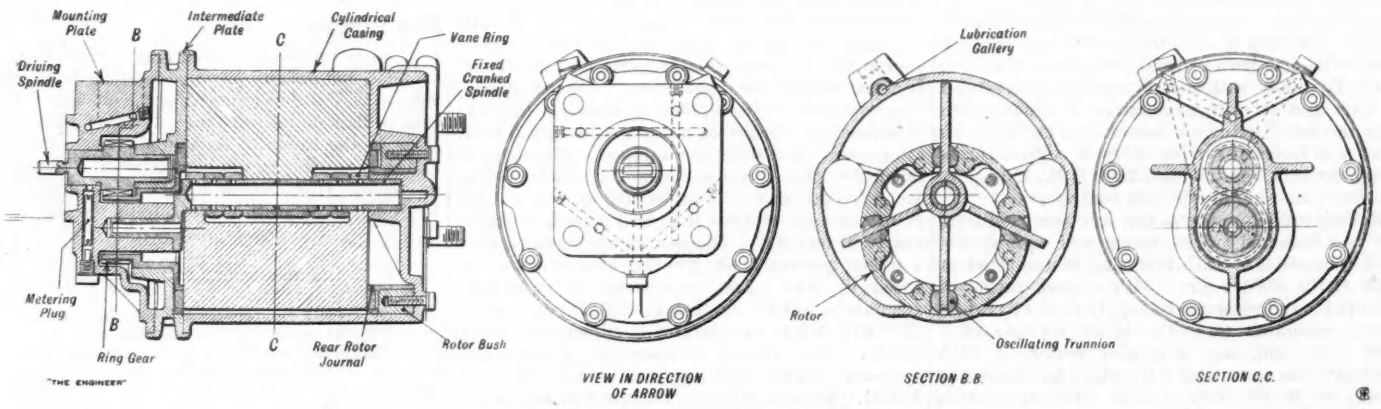
The four vanes work in the steel oscillating trunnions and are arranged to have a small clearance from the casing. They are therefore made of extruded Elektron alloy. The vanes are mounted on rings, suitably spaced to reduce rocking, on a fixed crank spindle concentric with the casing. This spindle, which is hollow, is made from alloy steel bar. It is a tight push fit in bosses which are integrally cast with the mounting plate—see drawing—and back plate, and it is prevented from twisting by two dowels which are a push fit in the spindle web and a forced fit in the spindle boss. The vanes are axially located by the steel revolving rotor end plates.

In many early pumps of similar basic design to that under description, one of the set of three, four, five, or more vanes was made the " master." It alone was driven, and through it was transmitted the drive to the rotor and thence to the other vanes. But in the Fenton-Smith pump it is the rotor which is driven. Thereby no one vane is called upon to do more work than any other, and in consequence the vanes wear evenly. The rotor is driven through an externally toothed ring gear, an arrangement which, as will be seen from the drawings, permits the rotor itself and the fixed crankshaft spindle to be properly supported at each end. The drive end rotor end plate is integral with the ring gear and the blank diameter of the ring gear is smaller than the rotor journal bearing, so that the ring gear can be pushed through the rotor bearing. Thus the hollow ring gear projects from the intermediate plate and revolves round the outside of the cranked spindle boss. It does not, however, come into contact with it.

Reference has already been made to the intermediate plate. It is an Elektron alloy casting and forms one end of the working chamber. Being of Elektron alloy, it forms in combination with the steel of the rotor end plate a suitable bearing combination, and the rotor journal is thus formed directly in it. It also carries one end of the steel driving spindle, which gears with the ring gear on the rotor end plate. This bearing has a blind end to reduce oil flow into the pumping chamber. Beyond the intermediate plate and carrying the other end of the driving spindle and the cranked end of the fixed spindle is the mounting plate, an Elektron alloy casting. On its outer side it is formed as a standard square or circular flange, as may be specified. The driving spindle, the end of which projects out of the mounting plate, can be provided with a standard tongue driving coupling or a standard splined coupling. To ensure alignment the cylindrical casing and the mounting plate are spigoted into the intermediate plate. They are also held in the correct position by two dowels which are a force fit in the intermediate plate and a push fit in the blind holes in the mounting plate and cylindrical casing. Ten studs hold the two plates in position.

Either end type or side type ports can be fitted to the pump to suit the particular engine installation. Internally, the working chamber is well sealed against leakage losses. An area seal, it will be observed, is provided between the circular cross section rotor and the casing, and the recesses in which the rotor end plates revolve in the back plate and intermediate plate also act as area seals. The maximum permissible speed of the driving spindle is 4000 r.p.m.

The lubrication system is particularly complete. The pump is intended to be mounted on the aircraft engine, and is fitted with a standard flange for the purpose. There are standard position oil holes in this flange to take lubricant from the engine, and as will be noticed from the drawing, the holes are so arranged that the attitude in which the pump is mounted does not matter. All four oil holes communicate with a longitudinal gallery in the casing, and there is a union boss cast in the casing which also communicates with the gallery, so that the pump can be lubricated from an external pipe, if it is so desired. Every plain bearing is positively pressure lubricated through its own individual feed channel from the longitudinal gallery. In each channel there is a floating metering plug, consisting of a short cylindrical rod whose clearance in the channel is adjusted to permit the passage of the correct amount of lubricant. As these plugs are driven up against end faces by the pressure of the oil, slots are cut in their ends to permit the oil to get past the faces. They also act as individual filters. Oil also passes through another metering plug into the hollow fixed crank spindle, and thus through drill ways to the vane ring bearings. Under the action of centrifugal forces, this oil is then carried to the oscillating trunnions. The gears are lubricated by oil which passes out of the ends of the driving spindle and rotor bearings in the intermediate plate.



ARRANGEMENT OF ROTARY VACUUM PUMP

Steam Turbine Nozzle and Blading Efficiency*

By F. DOLLIN, B.Sc.(Eng.), A.M.I. Mech. E.†

Introduction.—In the generation of electrical power, higher boiler pressures and temperatures, regenerative feed heating, and intermediate resuperheating have greatly extended the working range and increased the basic efficiency of the cycle. The increase of initial pressure and temperature makes it more difficult to attain and maintain a high level of turbine efficiency. Unless this is done, however, the potential gain due to improvement in the steam cycle may be frittered away.

Concurrently with these thermodynamic advances, and in large measure stimulated by them, there have been improvements in the mechanical design of turbines and in the hydraulic or aerodynamic efficiency of nozzles and blades. Evidence of the former is seen in the trend towards the highest possible speed of rotation and the evolution of systems of centre line support and cylinder constructions designed to avoid distortion and minimise parasitic losses. Improvement in the inherent efficiency of turbine components, especially nozzles and blades, is a continuous development resulting in the main from private researches by individual turbine builders. A notable exception, however, was the work of the former Steam Nozzles Research Committee of the Institution. Since the appearance of the Committee's sixth and last report comparatively little has been published in this country about this aspect of turbine development. There have, however, been many private researches consequent upon the work of the Committee, and the present paper touches on some researches of this kind.

Energy Conversion in a Turbine Stage.—The energy available for producing momentum or doing work in any one of a series of turbine stages is made up of two components: kinetic energy due to velocity of approach, and potential energy due to pressure difference between inlet and outlet. This applies both to the complete stage and to the separate elements (usually one fixed and one moving) comprising the stage. Available energy due to pressure drop can be utilised with an efficiency η_1 and available kinetic energy with a lower efficiency η_2. The fact that η_2 is partly due to the entrance losses associated with the carry-in and partly to the fact that in Nature potential energy tends towards a minimum. The transformation of kinetic energy into potential energy is well known to be more difficult to accomplish than the converse, while the utilisation of the kinetic energy of a fluid to do work, being neither aided by nor contrary to the tendency of Nature, will be of intermediate difficulty.

An explanation of the conditions tending to produce high kinetic losses as an accompaniment to a rising pressure gradient is suggested in the discussion of certain test results.

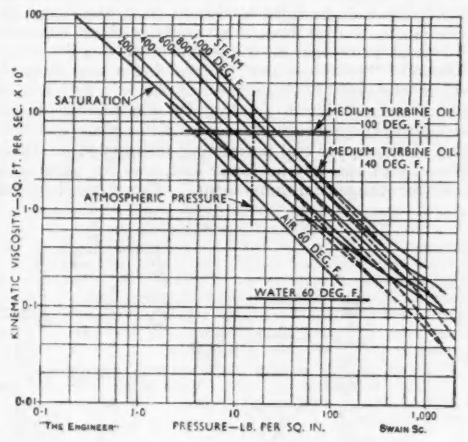
Static and Dynamic Tests.—A full determination of the relative efficiencies of different forms of blading necessitates comparative tests over a suitably wide range of velocity ratio in an experimental turbine. The turbine must be a multi-stage machine in order to include the effect of utilisation of carry-over from row to row and to enable the effects of varying the relative positions of adjacent stages and the arrangements adopted to minimise parasitic losses to be studied. Static tests, on the other hand, provide means of investigation in some ways more searching than the turbine test, which measures the overall efficiency but does not lend itself readily to analysis.

The dynamic efficiency of a turbine stage is defined as the ra io of the work done to the available energy in the stage. It is determined experimentally in a turbine from measurements of the power output, rate of steam flow, and terminal steam conditions. Static tests, on the other hand, lead to a determination of the "velocity coefficient" of a group of nozzles, *i.e.*, the ratio of the average forward discharge velocity to the velocity equivalent to the available energy. Although the discharge velocity will not be uniform over the cross-sectional area of the discharge, the jet momentum varies directly as the average velocity, and Oakden (1931) has shown that the work the jet from a nozzle with a given angle of discharge can do on moving blades is directly proportional to the square of the average jet velocity. For a nozzle with a given angle of discharge, therefore, the square of the velocity coefficient forms a measure of its useful efficiency.

A correlation of static nozzle tests and dynamic turbine tests can therefore be expected, both for impulse and reaction blading, if the nozzle discharge angle is constant. Correlation of static and dynamic test results on nozzles having different discharge angles, however, can only be attempted for 50 per cent. reaction blading, in which the stationary and moving rows comprise nozzles of similar shape, but opposite hand, and even then direct comparison cannot be made.

A straight elementary nozzle has a very high efficiency, whilst a curved nozzle has additional losses, associated in some way with the turning of the direction of the steam, and increasing as the angle of turning increases. For nozzles as arranged in multi-stage turbines (assuming a constant inlet angle), increase in the angle of turning means a reduction in the discharge angle relative to the plane of the nozzle outlet edges. Zero discharge angle would imply zero opening coefficient and hydraulic mean depth of passage. The attainable nozzle efficiency is therefore zero for zero discharge angle and rises to a maximum for a discharge angle of 90 deg. The dynamic efficiency, however, depends on the "diagram efficiency" as well as the nozzle efficiency. It will be zero for zero discharge angle because the nozzle efficiency is then zero. It will also be zero for a discharge angle of 90 deg., since the stationary and moving elements are similar and the steam has no tangential component of velocity. There will be some intermediate angle or range of angles for which the turbine efficiency will be a maximum.

The relationship between static nozzle efficiency and dynamic efficiency for 50 per cent. reaction blading is examined mathematically in Appendix I (not reprinted). The major factor affecting the ratio of static nozzle efficiency to dynamic blading efficiency is the jet discharge angle α. If the nozzle efficiency is less than unity, the ratio of static to dynamic efficiency is always greater than unity and increases as α increases. For blades with normal opening coefficients the ratio is in the region of 1·01 to 1·02, but in the limit when $\sin \alpha = 1{\cdot}0$ it becomes infinity, corresponding to zero dynamic efficiency. The calculated values depend to a small extent on the ratio η_2/η_1. Neither η_1 nor η_2 can be measured directly, but they can be inferred fairly well from tests with different forms of blading at varying



—— High-pressure steam data (Hawkins, Solberg, and Potter, 1939).
- - - - - High-pressure steam data (Sigwart, 1936).

FIG. 1—*Kinematic Viscosity of Steam and Other Fluids*

velocity ratios. As a rough guide under normal conditions, *i.e.*, when the inlet velocity is in an approximately axial direction, η_2 may be taken as equal to η_1^2. As a possible upper limit η_2 may be taken as equal to η_1, while if the inlet velocity is far from axial it is probable that $\eta_2 < \eta_1^2$. The small effect of such variations in the assumed relationship between η_2 and η_1 is shown by plotting the ratio η_n/η_b against $\sin \alpha$.

Static methods of testing can very conveniently and appropriately be used to study the effect on blading efficiency of such factors as blade width, blade height, edge thickness, surface finish, lacing wire, ratio of pitch to width, blade profile for given angle of entrance and discharge, and pressure ratio or theoretical jet speed. Interpretation of the results involves consideration of the effect of the Reynolds number on the absolute values obtained in the tests and examination of the results for any incidental and unintended variation between tests, particularly in regard to the discharge angle.

Tests with static apparatus have the important advantage of facilitating visual observation of the flow and exploration of the velocity and pressure distributions. Such explorations focus attention where the losses are concentrated and give an insight into the nature of the flow. Future testing can then be directed so as to produce the most useful results with the minimum number of tests.

Choice of Working Fluid: Reynolds Number.—For an experimental turbine, steam is in general the most convenient and appropriate working fluid, for a variety of reasons. In static testing, however, other factors operate to make some other medium—usually compressed air—the most suitable working fluid. The question then arises, what effect, if any, has the nature of the working fluid on the results?

Theoretical investigations (Oakden, 1928; Ackeret, Keller and Salzmann, 1934) lead to the conclusion that the two independent parameters determining the flow pattern with a compressible (gaseous) working fluid in a passage of given configuration are (*a*) the Reynolds number, and (*b*) the pressure ratio, or, more exactly, the Mach coefficient. The latter is the ratio of the actual to the acoustic velocity in the fluid, and takes account of the effect of the compressibility of the fluid on the distribution of inertial forces in the fluid field. There is some support for the view that this effect is secondary if the Mach coefficient does not exceed about ¾.

If hydrodynamic test results on a model of given form are to be truly representative of the geometrically similar prototype, the flow pattern must be the same in each case. The flow pattern is determined by the action of all the forces acting on the fluid particles. For a pipe or passage running full, or a solid body immersed in a fluid, the forces acting on the fluid particles are of two kinds, inertial and frictional. The former correspond with the accelerations of the particles and the latter with the viscosity of the fluid. The magnitude of the inertial force is equal to the mass of the particle multiplied by the acceleration:—

$$I \sim (L^3 \rho)\,(L\,T)^{-2} = L^2 \rho V^2 \quad . \quad . \quad . \quad (1)$$

where I is the intertial force and L^3, ρ and V are respectively the volume, density and velocity of the particle.

The magnitude of the viscous force is equal to the combined product of the surface area of the particle, the viscosity and the velocity gradient:—

$$F \sim L^2 \,.\, \mu \,.\, T^{-1} = L\,\mu\,V \quad . \quad . \quad . \quad (2)$$

where F is the viscous force and μ the coefficient of viscosity. Dividing equation (1) by equation (2),

$$\frac{I}{F} \sim \frac{L\,\rho\,V}{\mu} = \frac{L\,V}{\upsilon}$$

where υ is the kinematic viscosity of the fluid.

Now, $L\,V/\upsilon$ is the Reynolds number and is directly proportional to the ratio of the inertial to the viscous forces. The significance of the Reynolds number is therefore this, that in fluid flow experiments where the only forces to be considered are inertial and viscous and where conditions of geometrical similarity are observed, equal Reynolds numbers denote equal ratios of inertial to viscous forces and therefore similarity of flow pattern.

Geometrical similarity of form is evidently necessary if similar flow patterns are to exist in different passages and the Reynolds number can only be applied for correlating tests on geometrically similar passages. If geometrical similarity is interpreted strictly, so as to include not only blade profile, setting and spacing, but also mean diameter and blade height, this is a condition that is achieved so rarely as to be of little value as a basis of comparison. To obtain a useful basis of comparison the factors which are normally the least important, namely, mean diameter and blade height, may be ignored, whilst for very short blades in which the end effects are severe a correction for "aspect ratio" should be introduced. Allowance for end effects, however, may be made in the Reynolds number itself by choosing as the characteristic linear dimension of the blade passage the hydraulic mean depth. The choice of hydraulic mean depth at the throat as the linear dimension is as good as any other for strictly similar passages and has the advantage that when height varies it makes an allowance for end effects in inverse ratio to the blade height. The fluid velocity and kinematic viscosity at the throat are convenient and logical quantities to associate with the hydraulic mean depth in defining the Reynolds number. The absolute value of the number is immaterial. The criterion is equality of the number between model and prototype.

In considering the Reynolds number as applied to the blade passages of a steam turbine, an element of uncertainty exists on account of serious discrepancies between the results of three modern researches into the viscosity of steam. Data published by Hawkins, Solberg and Potter (1935) and by Sigwart (1936) showed good agreement at low pressures, but a discrepancy of something like 2/1 or 3/1 at very high pressures. Further experiments by Hawkins, Solberg and Potter (1939) showed some modification of the 1935 results, but confirmed their general nature. Fig. 1 is a logarithmic plot of kinematic viscosity against pressure according to these latest figures (solid lines) and according to Sigwart (dotted lines). The former have been used to compute Reynolds numbers given in this paper which fortunately is mainly concerned with the region where the two sets of data are in reasonably good agreement.

Fig. 1 also shows the kinematic viscosity of air at 60 deg. Fah. The air line runs parallel to, and somewhat below, the steam lines. If, for instance, the use of air at 60 deg. Fah. is being considered as an alternative to steam at 400 deg. Fah., both at atmospheric pressure, the kinematic viscosity would be in the ratio of about 1·5/4 and to obtain the same Reynolds number the product of the linear scale and the fluid velocity would have to be in the same ratio. If, in addition, the same Mach number is to be obtained in each case, appropriate velocities must be chosen to effect this, and must be combined with the scale ratios required for equal Reynolds number. The kinematic viscosities of water at 60 deg. Fah. and of a heavy medium turbine oil at 100 deg. Fah. and 140 deg. Fah. are also shown on Fig. 1 (for present purposes it is assumed that the viscosity is independent of the pressure). The figure shows strikingly how low-pressure steam is kinematically more viscous than a turbine oil, while high-pressure steam is less viscous than water.

The actual variation of Reynolds number from the first stage to the last in three typical reaction steam

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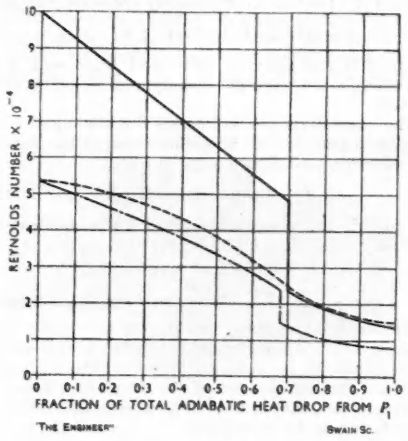
† C. A. Parsons and Co., Ltd., Heaton Works, Newcastle-upon-Tyne.

turbines is shown in Fig. 2. The Reynolds number falls continuously as the expansion proceeds, the ratio of the initial to the final value varying from 3·6/1 to 7·5/1. This variation gives the experimenter considerable latitude in the choice of scale ratios and steam or air speeds.

If it is not possible or convenient to have equal Reynolds numbers in the model and prototype tests, this does not necessarily invalidate the test results. Experiments on flow in pipes have shown that at fairly high Reynolds numbers the friction coefficient shows little variation over a wide range of Reynolds number. It might be expected, therefore, that if the Reynolds



Steam pressure at stop valve, 600–650 lb. per square inch; steam temperature at stop valve, 800–850 deg. Fah.; vacuum, 28·5–29·0in. of mercury.

Curve.	Output at continuous maximum rating, kW.	Speed, r.p.m.	No. of exhausts.
———	50,000	3,000	2
—·—	30,000	3,000	2
- - - - -	50,000	1,500	1

FIG. 2—*Variation of Reynolds Number in Typical Reaction Steam Turbines*

number in the model tests is not appreciably less than in the prototype the results will not be materially different. In any case if the same dynamical conditions are maintained in a series of model tests the results should be comparable among themselves.

Description of New Nozzle Tester.—Static tests on turbine elements may be carried out either by methods of exploration and integration, or by overall measurements giving average quantities directly or by deduction. Methods of exploration and integration have been widely adopted and highly developed in recent years, especially in the U.S.A., where apparatus has been constructed incorporating automatic means of carrying out the traverse and integrating the results (New, 1940; Kraft and Berry, 1940). Methods based on overall measurements involve determination of the average discharge velocity from measurement of the quantity of fluid passing and the impactive or reactive force of the discharge. The Steam Nozzles Research Committee of the Institution adopted an impact form of tester. Most investigators, however, who have set out to determine the average discharge velocity have chosen to measure the reactive force of the jet.

A reaction type nozzle tester using a previously described principle, but embodying several new constructional features, was built by Messrs. Parsons some years ago and has proved very useful in service. It follows the principle of the A.E.G. experimental turbine designed by Dr. Baer some years ago (Faltin, 1926). The nozzles are supported in such a way that they have limited freedom of torsional and axial movement, and balances are provided so that, when the nozzles are displaced under the influence of the reactive forces of the discharge, the tangential and axial forces required to restore them to neutral can be measured. A tester of this kind has the important advantage that it provides a direct measurement of the discharge angle as well as the velocity of the jet. It also permits tests to be made first on a nozzle alone and then on the combination of the nozzle and a row of moving blades on a wheel overhung from a dynamometer, thereby providing information on pressure and velocity changes in the blades and in the clearance space between the nozzle and blades.

The machine constructed by Messrs. Parsons differs in almost every detail from the A.E.G. machine. Air was chosen as the working fluid instead of steam in order to avoid the necessity of enclosing the machine, thereby facilitating inspection and testing. A second fundamental change is that the "rotor," instead of being supported in anti-friction bearings, is suspended by members incorporating special spring devices which permit limited movement in both the torsional and axial directions, so that friction is practically eliminated.

Fig. 3 is a sectional view of the nozzle tester. The rotor comprises a horizontal pipe carrying a nozzle chamber at one end and a balance weight at the other. The pipe is surrounded by a gland which comprises a fixed casing carrying sleeves on which are turned a large number of internal radial fins, the edges of which are just clear of the outside diameter of the pipe. Air under pressure enters the rotor through a number of slots cut in the wall of the pipe and passes to the nozzle chamber, whence it is discharged to atmosphere by the nozzles under test. A small proportion of the air entering the gland housing escapes

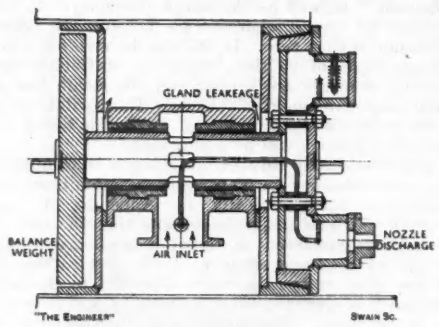


FIG. 3—*Static Nozzle Tester; Sectional View*

to atmosphere through the clearance space between the sleeves and the rotor pipe.

Figs. 4 and 5 show diagrammatically the rotor suspension and the torque and thrust steelyards. The rotor is suspended at each end by a pair of radial members X X at right angles to each other and at 45 deg. to the vertical. Flexibility without extensibility is provided in the suspension members by means of "plate centres" comprising a thin strip of spring steel held between two flat plates in such a way as to permit slight bending in one plane. Each suspension member incorporates three plate centres, one at the upper end permitting rotation in an axial plane, and two at the lower end, one for axial and one for tangential movement. The rotor is thus

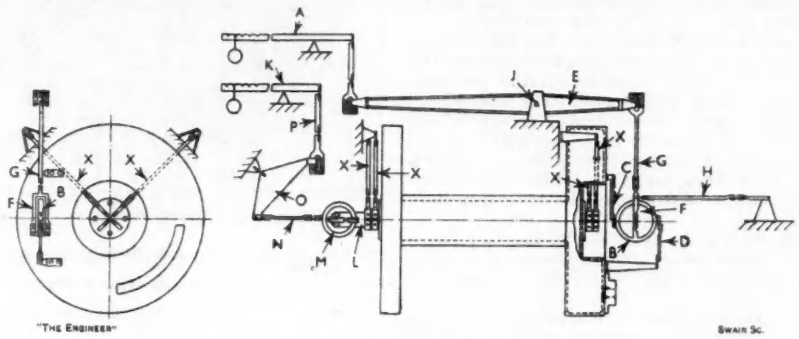


FIG. 4—*Static Nozzle Tester; Diagrammatic View of Nozzle Discharge End*

FIG. 5—*Static Nozzle Tester; Diagrammatic Side Elevation*

free to rotate and to move axially under the reactive force of the jet issuing from the nozzle under test. Stops are provided to limit the movement and so avoid overstressing the springs.

One steelyard is provided to balance the torque and another to balance the thrust. These steelyards are operated by linkages from the rotor body, and it is essential that they should be completely independent of each other. In taking readings of torque and thrust, both steelyards are adjusted to float with the jockey weights at zero when no air is flowing; when steady conditions of flow are established the jockey weights are readjusted until both steelyards are again floating. Since both steelyards will only float simultaneously when the rotor is in one particular position, both axially and rotationally, it follows that there can be no change in the loading of the springs and hence the steelyards give a direct measurement of the dynamic forces.

The linkage between rotor and steelyards is also shown diagrammatically in Fig. 5. The upper steelyard A measures the torque. If the torque on the rotor is in a clockwise direction as seen in Fig. 4, ring B to the right of the nozzle box in Fig. 5 will be pushed and pulled upwards by the two vertical members C and D attached to it at opposite ends of the horizontal diameter. This vertical movement is transmitted to the beam E operating the upper steelyard by the stirrup F and flexible link connection G. If at the same time the rotor is displaced horizontally, links C and D assume a slight obliquity and the ring B a slight rotation. Horizontal movement of the link G is prevented by the horizontal link H from the top of the stirrup to a fixed anchorage, the stirrup being free to adjust itself by means of the plate centres at its lower end. Fulcrum J is also of the plate centre type, there being no knife edges or pin connections at any point.

The thrust steelyard K is connected to the balance weight end of the rotor by the linkage shown in Fig. 5. Horizontal movement of the rotor is transmitted by a stirrup L and ring connection M, through a horizontal link N, bell crank O and vertical link P to the steelyard. Links N and P incorporate plate centres permitting the necessary temporary obliquity of the links, and the fulcrum of the bell crank is again a plate centre. Stirrup L is connected to ring M by a pointed pivot coaxial with the rotor so that rotation of the latter does not affect the thrust steelyard.

It has been found in practice that these arrangements effect complete independence between the torque and thrust measurements, with practically complete absence of friction. The rotor and nozzle chamber must be rigid, and must not distort or distend under the influence of the internal pressure to which they are subjected while nozzles are being tested. The nozzle chamber is provided with distance pieces and tie bolts (Fig. 3) to assist in achieving this condition.

To enable the pressure of the air before it enters the nozzles under test to be measured, a gauge pipe is led into the air inlet pipe, through one of the slots in the rotor pipe and along to the nozzle inlet chamber, where it terminates as a ring main in which a number of small holes are drilled so as to read the mean pressure in the nozzle chamber. This arrangement obviates any external connections to the nozzle chamber which might introduce extraneous readings of thrust and torque. The area of approach to the nozzles is large in relation to the discharge area of the nozzles themselves, so that kinetic pressure effects due to the velocity of approach are small. The temperature of the air before the nozzles is measured by a mercury thermometer in a Callendar pocket in the nozzle chamber.

The air supply first passes through a metering nozzle of the "I.G." pattern, and thence to the nozzle tester inlet. The "I.G." pattern of metering nozzle was adopted because of the precise specification and extensive data relating to its characteristics, published by the V.D.I. The metering nozzle used in the present tests is 2in. in diameter and is installed in a 6in. pipe having a straight length of 9ft. before and 7ft. after the nozzle, a perforated plate to break up large eddies being provided at the inlet end of the pipe. Calibration tests of the metering nozzle *in situ* were made over the range of pressure ratio and Reynolds number required in service, using steam as a working fluid. The flow coefficients given by these tests corresponded closely with the values given by the V.D.I. curves for corresponding conditions.

A small proportion of the air entering the tester escapes to atmosphere through the gland clearances. The leakage quantity depends on the pressure in the nozzle chamber and is measured by blanking off the discharge opening from the nozzle chamber, installing a very small metering orifice in the supply pipe, and regulating the admission of air to the system to establish any desired pressure in the nozzle chamber. The leakage is thus checked from time to time and is found to be practically invariant with time, as would be expected in view of the static operating conditions and the small range of temperature variation.

(To be continued)

Sensitised Metal Templates

THE Carter processes were first used in England in the year 1928 for the making of templates in the manufacture of guns, automobiles and ships. With the complete success of the method on copper, steel, brass, aluminium, plastic, wood, cloth, &c., the engineers developed the idea of not only using it for templates, but in duplicating fixtures, tools, jigs and parts for all types of metal fabrication.

In the making of a boat, aeroplane or tank the first step toward making a new model is the template development for the body group and the releasing of the lay-out of the body lines. When this is complete it becomes a master reference, permitting the next step to be made, which is that of transferring lines and contours from the loft tables on to translucent sheets used in the process. These sheets, when finished, constitute individual full-size lay-outs of the major transverse bulkheads, interspar beams or other major or minor details of the structure.

When the drawings, up to 10ft. by 12ft., are completed the production department has already ordered the sensitized metal sheets in the necessary numbers

to make up the machines. The translucent sheet with its full-scale drawing now becomes the actual photographic negative. These drawings are placed over the sensitised metal and, with a quarter of a second's exposure and three minutes' developing and fixing, the tool departments, fabrication departments and the assembly departments have any number of metal sheets that may be immediately fabricated into the finished machine.

By means of these processes the work of photo-printing from the translucent sheets on to duralumin, steel, plastic, wood, cloth or other surface is the work of a few seconds. When the photo prints are completed they are the templates that constitute the sole means of reference for the shops in the fabricaton of parts and in the assembly of parts into the completed bulkhead or beam.

The old system of drawing on paper in half or quarter size and then having the metal fabricators translate the drawing to metal is completely eliminated. The new processes rapidly supply any number of full-scale completely detailed photo drawings on metal. The business of the fabrication department is rapidly and accurately to follow the lines, contour, bending and punching instructions on each sheet.

Only one objection has been raised in connection with this new process of metal fabrication. This objection comes from the template building department; the complaint is that an average draughtsman cannot accurately draw a template requiring precision within 0·001in. However, the fact has been demonstrated that a skilful draughtsman can draw as accurately with a sharp lead pencil on a smooth surface as a template maker can scratch with a sharp point on a metal surface.

The Metal Photo-Drafting Company, New York, is installing plants that include a complete metal inhibiting and metal sensitising department, photo printing and developing department, and personnel to carry out the making of full-scale drawings on metal.

An Accident and Efficiency

PARTICULARS of an unusual accident have reached us from a correspondent in the South Midlands. The scene of the accident was a roundabout on a by-pass road. Partly because of frost, snow and the contour of the road, partly to avoid a collision, and partly owing to the nature of the load, a 3-ton lorry carrying a tank holding liquid air skidded and "turned turtle," landing athwart the road with the cab down at one end and the rear wheels skyward, and on top of the domed cylinder. Happily, neither the driver nor his mate were seriously hurt, and before the former accepted proffered first-aid help he telephoned to his base, 50 miles away, and reported the accident and his position. Eighty minutes later or thereabouts a small car drew up and from it stepped a man who took charge of the salvaging work. Next a lorry with another cylinder turned up and was promptly sent on to an undisclosed destination, thereby ensuring no break in work somewhere of national importance, which involved oxy-acetylene welding. Then there arrived a big lorry with a complement of tools and tackle. The bolts round the tank flange were removed—or as many as could be shifted—and a wire tow rope was passed round the wrecked chassis. First the cab and then the rear end was tried, but the lorry failed to drag the chassis clear of the cylinder; the cab crumpled up and one bolt could not be shifted. By this time two road cranes had appeared "out of the blue" and by different roads. After a short conference one was sent away and the other ranged alongside the wreck. First the chassis was lifted clear of the cylinder and dumped on the road, then the tackle was readjusted and it was turned over and lifted bodily on to the lorry. Then the craneman tried to turn the cylinder over, but decided that the risk of a second mishap was too considerable. After some forthright observations about the alleged weight and his own estimate of it, he lowered the hook, the men disengaged the slings and he moved his crane so as to bring the rear end near the cylinder, which was first turned on its side, then on its base, and after a third change of slings was lifted bodily on to the rear end of the lorry. The accident occurred between noon and one o'clock, and before 6.30 p.m. the lorryman was told to go to "the car park until to-morrow morning" and the crane sent back to the aerodrome from which it was borrowed. Very little of the oxygen had escaped and at no time during the whole of the period was the traffic diverted from the roundabout, despite the number of vehicles, which included lorries carrying bricks, cement and other heavy loads, Army wagons by the score and so many cars that one wondered where—if anywhere—there was a shortage of petrol.

SYNTHETIC RUBBER FOR TYRES.—The Goodyear Tyre and Rubber Company has announced the impending erection of a plant in Akron, for the manufacture of "Chemigum," a synthetic rubber made from petroleum-cracking gases, at the rate of 10,000 lb. daily. Plans for further large expansions in manufacturing facilities for the new material in the event of a national emergency are also being formulated by the company.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Uniformity in Government Steel Purchases

The following notification has been issued by the Ministry of Supply, Iron and Steel Control:—An important step was taken in the last quarter of 1940 to put the procedure under which Government Departments authorise the purchase of steel on a uniform basis. All Government Departments are now issuing their authorisations to acquire steel on a standard Form "M." This form gives the necessary authority to a contractor to order steel by quoting the symbol of the Government Department concerned, the Department authorisation number, and the period for which the quantity of steel authorised may be ordered. The steel may only be ordered for the purposes stated on the Authorisation Form, or to replace steel used for the purposes referred to on the form; also, in placing the order with steel product makers, the contractor must state "authorised on Form 'M'" to show that he has received the necessary Authorisation Form. The authorisation given to contractors enables the firm either to buy directly from the makers of steel products up to the tonnage specified, or to issue sub-authorisations also on Form "M" to sub-contractors for any part of the tonnage authorised. Contractors requiring to issue sub-authorisations under their own authorisation can obtain the necessary copies of Form "M" from the Government Department, or contractor acting for a Government Department, from whom they received their own authorisation. The foregoing procedure covers 90 per cent. of the steel requirements of the country, and its general purpose is to ensure that firms only acquire steel for purposes approved by Government Departments in connection with their various programmes of munitions, aircraft, &c., and within the allocations given by the Government to each of the Departments. In the case of equipment required by factories which may be engaged on work for various Government Departments, or on civil work, it may not be possible to obtain an authorisation from a Government Department as the work involved is not the responsibility of one particular Government Department. In this case, permission to acquire the steel involved is obtained by a licence from the Iron and Steel Control, to whom application should be made in all cases where the steel is not covered by an authorisation on Form "M" from a Government Department. Apart from the licences issued by the Iron and Steel Control, the only exception to the use of Form "M" is in the case of certain authorisations issued by Government Departments prior to October last. In these cases, the standard Form "M" was not yet in use, and the Departments gave the necessary authority to quote their symbol, &c., on their own forms. In certain cases, therefore, the contractor may not be in a position to state that he has been authorised on Form "M," and, provided that the particulars as to Department are properly set out, steel can, in the meantime, be ordered under these pre-October authorisations. In none of these cases, however, may any particulars regarding Government contracts, whether they are contract numbers or other details, be quoted in order to acquire steel unless they are part of a written authorisation given by a Government Department specifically for this purpose. Recently, a further arrangement has been made whereby alloy and carbon steel is allocated separately between the Government Departments, and as a result of this arrangement a special Form "Ma" is used to authorise alloy steel. Until this new form can be printed and brought into general use, Government Departments will stamp the existing Form "M" "Alloy Steel" when the purchase of alloy steel is authorised. When alloy steel is not covered the form will be stamped "This form does not authorise the purchase of alloy steel." Care should be taken, therefore, to ensure that no alloy steel is ordered under an authorisation which specifically excludes the purchase of alloy steel.

The Pig Iron Market

Conditions in the pig iron market have not materially changed, but one or two tendencies which have been noticeable during the past few weeks have become more obvious. The collection of scrap, which has been carried forward energetically, has provided more material for the blast-furnaces engaged in producing foundry iron, whilst at the same time the production of high-phosphoric foundry has been increased to meet the heavier claims of the light castings foundries, which are better employed, generally speaking, than for many months. Supplies for this trade come largely from the Derbyshire and Northants pig iron makers, and it is satisfactory to note that the supplies appear adequate to meet the increased call. Little foundry iron is being produced on the North-East Coast, where production is principally concentrated upon steel making irons. In fact, there seems little prospect of the manufacture of foundry iron being resumed upon any scale in this district. It is evident, however, from the freedom with which licences are issued for this class of iron that there is no stringency in the market and in a few cases consumers have been able to build up some reserves, as the Control apparently can see its way to be a little more liberal in this respect. Generally speaking, however, the stocks are low in consumers' yards. In the Midlands also there has been a noticeable revival in the demand for high-phosphoric foundry. The engineering foundries are fully occupied in all districts and are taking large tonnages of low-phosphoric and hematite. A few weeks ago there was some tightness in the supply of these descriptions, but imports from the United States have eased the situation, which has been further improved by the adoption by the Control of a more direct system of distribution. Jobbing foundries in Lancashire are somewhat irregularly employed. Good quantities of foundry iron, however, are passing into use in this branch of the industry, and foundries associated with engineers engaged on certain types of munitions have more work in hand than they can conveniently cope with. Whilst a few plants in Scotland ceased work at the New Year to carry out badly needed repairs, the usual seasonal stoppages did not take place. The production of pig iron was maintained throughout the normal holiday period, and consuming works continued to take deliveries.

Scotland and the North

The Scottish steel works are operating at full pressure and it is anticipated that they will be employed at capacity for months to come. All the consuming trades in Scotland are extremely busy and have orders in hand sufficient to keep them engaged for the whole of the first quarter. It is expected that the war effort will increase during the first few months of this year and that the immediate effects will be seen in the iron and steel industry in greater pressure for supplies. The demand has not only become stronger, but it has also broadened to include many classes of steel which were not in such active request a comparatively short time ago. There is no doubt that Government requirements will continue to take the greater part of the production. The demand for special steels for armaments and munitions has noticeably increased, and in all probability will grow still further. The requirements of the shipyards continue heavy and large tonnages of plates and other shipbuilding steel are constantly moving to this industry. A large programme of work at the yards ensures that this demand is not likely to relax for a long time. The marine engineering establishments, naturally, are also busy in view of the huge amount of work at the shipyards, and it is expected that the new Government scheme for fabricated ships, in which a number of constructional engineers will participate, and on which some are understood to be already engaged, will ensure a continuance of and an even heavier demand for steel for shipbuilding purposes. The boiler and tank makers are large users of plates and are fully engaged upon Government work. The demand for bars continues to expand and lately there has been a sharp request for the larger sizes. In the Lancashire market there has been a fair demand for structural steel, although this has not been so heavy as in the early months of 1940. The demand for nickel and alloy steels has increased lately and has thrown a considerable strain upon the manufacturers.

Copper and Tin

The copper market does not present much change, but although no statistics are issued it is generally understood that the British Control is in a comfortable position as regards stocks. At any rate, the war industries are receiving all the copper they require, although, naturally, licences are carefully scrutinised by the Control, as it is probable that there is not a big surplus. In any event, prudence would indicate the advisability of conserving the use of copper, as it is amongst the most important of the war metals. The chief event of interest has been the extension in the United States of the export embargo to copper and copper products, which have been made subject to licence. The ostensible reason given has been that the United States requires so much copper for her own rearmament purposes that it is unwise to export without any limitation. It is thought probable, however, that licences will be issued for export to Great Britain and to countries in the British Empire. The copper situation in America is undoubtedly tight and for some weeks past the producers have allocated quantities to their customers which in effect has almost amounted to rationing. There is no doubt that large tonnages are required for the rearmament programme, and this was instanced recently when the United States naval authorities bought 1000 tons. The American Government, it is understood, has decided to build up a reserve of copper in the United States by importing it from South America. This metal, it is thought, will be allowed to remain in bond and will be taken as it is required for Government purposes, probably duty free. Prices in the United States have undergone no change from 12c. for domestic delivery and 10½c. to 10½c. for export, but it is reported that Japan has bought a few odd lots at 12½c. . . . There has been no development of importance in the tin market and prices have been particularly steady, moving only a few shillings either way. Interest has been aroused by the statement that a meeting of the International Tin Committee will be held in March. The view is taken generally that the question of quotas will again come up and that an attempt will be made to readjust them. If so, it is probable that the meeting will be a stormy one, as it would not suit the books of all the contracting parties to have their quotas altered.

Lead and Spelter

The lead situation in this country is regarded as satisfactory. Consumption continues at a high level, largely for war purposes, and good supplies continue to arrive with regularity. Reports have been current that some users who require metal for commercial purposes have found greater difficulty in obtaining supplies than has been the case recently, but this is probably due to the view taken by the Control that it is wise to conserve its stocks. Firms engaged upon the manufacture of exportable products, however, appear able to obtain fair supplies. The position of spelter has not changed and remains tight in most parts of the world. In this country the arrangements made at the commencement of the war have placed the Non-Ferrous Metal Control in a particularly strong position as regards this metal, although naturally it is necessary to exercise economy in its use. In the United States the situation is exceptionally stringent and, according to the American Zinc Institute's figures, the production during December totalled 59,883 tons, compared with 54,681 tons in November. Deliveries, however, rose from 61,145 tons in November to 65,385 tons in December and the stocks declined to 12,884 tons, which, it is estimated, is about a week's supply at the current rate of consumption. According to estimates which have been put forward by American spelter producers, it is expected that the industry there will produce at between 70,000 and 75,000 tons per month.

Notes and Memoranda

Rail and Road

ONE-MAN BUSES.—The Buenos Aires Transport Corporation proposes to purchase 200 buses—each with accommodation for 28 passengers—and 28 oil engines, to replace worn-out petrol engines. In the running of the new buses the services of conductors will not be wanted, as the tickets will be issued by the drivers, who will have sole control of the vehicles.

MILITARY HIGHWAYS.—The Canada-United States Joint Defence Board is considering construction of two international military highways, one along the Pacific coast from San Diego to Alaska, the other along the Atlantic coast from Miami to Nova Scotia. Each would have a concrete pavement 100ft. wide through a 500ft. right of way. These roads would carry heavy artillery, tanks, munitions and supplies in case of attack on either the United States or Canada.

A BUS GARAGE.—Plant for bus washing has been expanded at the Glasgow Corporation Transport Department's Knightswood garage, where is now accommodation for 280 vehicles. The plant deals with the sides and roof of the double-deck buses, which are slowly driven through it. There are vertical and horizontal power-driven mops, which are operated at 50 r.p.m. by two 40 B.H.P. electric motors, mounted on the top of the superstructure. The motors and the chain drives are protected from spray. The vehicles are guided through the washer by concrete kerbs, and after washing are rinsed by vertical sprays of clean water.

AN ELECTRIC MINING LOCOMOTIVE.—An Ohio mining company has placed in service a locomotive having eight wheels mounted in four axleless trucks. Each truck consists of two wheels in tandem, driven by a single motor. The arrangement ensures less friction on curves, and higher draw-bar pull. This company has also installed a mining sub-station which is as portable as the cars and small enough to go wherever they go, thus following the load. The transformer, ignition rectifier, and the controller of Westinghouse manufacture are mounted on two cars that can be drawn by a mining locomotive to an unused siding in a worked-out portion of the mine near the scene of mining operations. Especially important is the low height—only 46in.

THE WESTERN DESERT.—The railway to the Western Libyan Desert has assumed importance of late, and the *Railway Gazette* should be thanked for publishing some almost forgotten facts. Communications between Egypt and the front line, on and beyond the border, are maintained by the standard-gauge Western Desert extension of the Egyptian State Railways with its railhead at Mersa Matrouh, 294 kiloms. from Alexandria and about 120 miles east of the Libyan frontier. Beyond Mersa Matrouh is a motor road extending past Sidi Barrani, through Sollum, Bardia, and Tobruk, towards western Libya. The railway originated in a private venture, and was first built as a standard-gauge line only as far as kilom. 177 from Alexandria. Subsequently, a metre-gauge extension was constructed from kilom. 177 through Fuka to about 40 miles short of Mersa Matrouh. In February, 1914, the Egyptian Government purchased both standard and metre-gauge sections and their equipment, and when in the autumn of 1935 it was decided as a precautionary measure to station a defensive force at Mersa Matrouh, new work was begun, and the standard-gauge line was carried to Mersa Matrouh, a distance of 77½ kiloms. The new extension was opened to Matrouh on April 7th, five months after the decision to build the line. Actually, serious construction work began only on January 1st, and in the succeeding ninety-seven days nearly 100 kiloms. of earthwork, including a difficult cutting near Matrouh, permanent bridges, and culverts, permanent way, and stations were completed.

Air and Water

BRISBANE AERODROME.—A terminal building is to be erected at the Archerfield Aerodrome, Brisbane, by the Civil Aviation Department of Australia.

FRUIT FUMIGATION.—An increase in the export of fruit from Egypt has led to the installation in that country of a large new plant for the fumigation of imported fresh fruits and other commodities. Hydrocyanic gas and carbon bisulphide are the principal fumigants used.

INSTRUMENTS BY AIR.—The Qantas-Empire Airways service went out of Brisbane recently carrying some delicate scientific gear for the Shell Company. These were highly sensitive gravitational-measuring instruments for oil search being conducted by the company in Australia.

BUICK AERO-ENGINES.—Negotiations are now well-nigh complete under which the makers of Buick cars will make Pratt and Whitney aircraft engines in addition to Ford. The company will erect a new plant and equip it with new tools as Ford has done. The initial order will probably be for 4000 to 5000 engines.

AN AUSTRALIAN AIR LINER.—After five years' service, in which it has flown more than 1 million miles, a Qantas-Empire Airways air liner, "Melbourne," has been handed over to the Royal Australian Air Force. The "Melbourne," which pioneered the Empire air mail service in 1935, has never had a crash or forced landing. This, says *Flight*, is a wonderful record for a transport craft with five years' service. Until the flying boat service began in in July, 1938, the "Melbourne" and four other similar planes flew mail between Brisbane and Singapore. Since then the "Melbourne" has been on the inland service from Brisbane.

MONEL FOR BOAT NAILS.—American shipyards have been testing for comparison the holding properties of various fastenings used in boatbuilding. The results proved that a Monel nail of special design had a greater holding power than a screw. It was found that the nail could be driven into such woods as oak without drilling a pilot hole. The various fastenings tested were driven into steamed oak up to within $\frac{3}{32}$ in. of the head. Average results gave the Monel nail a holding power of 840 lb.; a No. 8 wood screw, 816 lb.; a copper nail, riveted, 708 lb.; a galvanised wire nail, clinched, 642 lb.; a galvanised wire nail, unclinched, 552 lb.; and an unclinched galvanised cut nail, 510 lb.

Miscellanea

A RISK OF EXPLOSION.—The Liverpool and Merseyside Industrial Safety Committee reports that when an electrician was repairing the cables on a main distribution box, he found on one of the cables a green deposit which looked like verdigris. After scraping the cable an explosion occurred, and subsequent investigation showed that what the man thought was verdigris was copper acetylide, produced by chemical action between the copper of the cable and acetylene fumes given off by a nearby pickle liquor well. As copper acetylide is a detonating composition it is fairly obvious what happened.

MATERIALS FOR WELDING.—The U.S.A. Bureau of Mines has drawn attention to the many changes that have occurred in welding processes. Fluxes to dissolve oxide coatings from the metals being welded were once the whole stock in trade of the welder. To-day, the coatings on welding rods for electric welding carry not only fluxes, but arc stabilisers, thickeners or thinners for the welding slags, deoxidisers for protecting oxidisable metals from attack by air, alloying elements to give stronger welds, binders to hold the rod coatings together, reinforcers, like asbestos fibre, to prevent cracking of the coatings, and many other functional ingredients.

OIL UNDER THE CASPIAN.—Volcanic action in the Caspian Sea has brought additional proof of the existence of oil under the sea bottom. A short time ago employees of the lighthouse on Svinoi Island, situated in the Caspian Sea, 43½ miles from Baku, were alarmed by continuous subterranean rumblings, investigation of which was undertaken by a commission of the Azerbaijan branch of the Academy of Sciences of the U.S.S.R. The scientists discovered active gas and mud volcanoes, ejecting fuel gas. Experts are of the opinion that these eruptions testify to the existence of rich petroliferous strata going deep down under the bed of the Caspian Sea.

PLATINUM IN AUSTRALIA.—Queensland reports the discovery of a complex platinum ore, associated with norite. The ore, although high grade and present in large quantity, has not hitherto been recognised as being of commercial importance. This is because of the unique nature of the combination in which the platinum group of metals occurs, viz., with thallium. Investigations indicate that the real difficulty in dealing with the ore can be overcome by preliminary treatment, which is simple when it is realised that the metals are present entirely in the form of stable complex compounds as an integral part of a homogenous basic igneous rock—a norite.

AMERICAN A.A. GUN.—According to the *Coast Artillery Journal*, the new American A.A. gun will be known as the 90-mm., M1. Although its developed rate of fire probably will be slightly less than that of the 3in., its projectile is considerably heavier; hence in overall effectiveness—number of effective fragments per unit of time—the 90 mm. represents a considerable improvement over the standard 3in. weapon. The projectile of the new gun also has a shorter time of flight than that of the 3in. for corresponding ranges and consequently a greater maximum useful range. In overall weight and in tactical mobility the two weapons are approximately equal.

FINDING THE HIGH PLACES.—Mr. H. G. Griffith, of Aberdeen University, has devised a means to facilitate machine scraping with increased accuracy and speed and without strain to the eyes. Instead of Prussian blue, a mixture is used of powdered anthracene in medicinal paraffin oil and the work, inspected under the rays of an Osira black glass lamp. The high spots fluoresce brilliantly enough to be clearly visible in a normally lighted room. After the high spots have been scraped down, the surface can be cleaned off with a rag moistened with benzene and the test repeated. The only apparatus required for this procedure is a standard 80-watt or 125-watt Osira black glass lamp and choke, with a simple concentrating reflector.

A HIGH-TEMPERATURE ALLOY.—The Westinghouse research laboratories have produced an alloy, containing only 7 per cent. iron, which is claimed to be stronger than any known steel. It retains its strength at temperatures higher than 2000 deg. Fah. The alloy, which is the result of almost seven years of research work, is actually stronger at 1100 deg. Fah. than ordinary low-carbon steel is at room temperature. Almost half of K-42 B, as it is known, is nickel, and about a quarter is cobalt. Other components include chromium, titanium, and iron. Production of the metal on a commercial scale is known to be practical, but its first cost will be high. Its immediate uses are expected to be those of a special-purpose alloy for dies, valves, steam fittings, and, possibly, turbine blades and other applications requiring temperature-resistant metals.

PLASTICS IN LIEU OF METAL.—The shortage of metal in Germany, says the *Chemical Trade Journal*, has led to investigation of plastics for engineering details, with a view to eliminating their defects as bearing materials. Overheating has been reduced by the use of more suitable lubricants, by redesigning the lubricating channels, and by water cooling. Water is prevented from entering the bearing surfaces by a non-emulsifying grease. Other bearings employ water-containing grease in emulsion as the cooling medium. Experiments are under way in which the shaft, as well as the bearing surface, is covered with plastic material. Plastics have been employed in bearing installations for ore-crushing and sorting machines, rolling mills, revolving cement furnaces, and calendars in the artificial rubber and other industries.

R.I.M.A.—This will be the short name of the Refrigeration Insulation Manufacturers' Association, an Association which has been formed with the object of promoting and protecting the business in commercial refrigeration, insulation, and kindred insulated products. The Association is affiliated to the British Electrical and Allied Manufacturers' Association, and its membership is open to all approved manufacturers in Great Britain of insulation for thermal control. The secretary is Mr. Felix A. Rogers, at Kern House, Kingsway, London, W.C.2.

AN HYDRO-ELECTRIC BLAST-FURNACE.—The Swiss Water Power Association, being desirous of developing a means of cheapening the electrical production of pig iron from Swiss ores, has again been investigating the possibility of building an electrical blast-furnace to be operated by hydro-electric energy. No final decision has yet been announced, although, after extensive trials, the Swiss Water Power Association reported to the Research Association for the utilisation of Swiss ore deposits, that it was quite practicable to reduce Fricktal and Gonzen ores in an electric furnace. Moreover, investigation of the possibilities of iron smelting and petrol synthesis in associated plants, led to the conclusion that the hydrogen required for the Fischer-Tropsch process of petrol synthesis could be made electrically. The next step lies with the Federal Government.

Personal and Business

MR. RONALD LESLIE has been elected a director of the Central Argentine Railway.

VULCAN FOUNDRY, Ltd., Newton-le-Willows, Lancs, announces that Major-General A. E. Davidson has joined its local board.

MR. G. W. LOWES has retired from the position of manager of the rolling mills of the Skinningrove Iron Company, Ltd.

MR. H. M. PEASE, who, from 1902 to 1928, was closely connected with the Western Electric Company and, later, with Standard Telephones and Cables, Ltd., has been elected to the presidency of the International Standard Electric Corporation, of New York.

THE LATE MR. R. B. SUMMERSON.—We regret to learn of the death of Mr. R. B. Summerson, chairman of Thomas Summerson and Sons, Ltd., who died on Friday, January 3rd, after a short illness, at his home, Hall Garth, Coatham Mundeville, in his eighty-fifth year.

We regret to announce the death at the age of eighty-four of Captain Alexander Williamson, a former local director of John Brown and Co., Ltd., Clydebank. Captain Williamson was a member of a well-known family which has owned and sailed passenger steamers on the Firth of Clyde for over a century.

LIEUT.-COLONEL LORD DUDLEY GORDON, D.S.O., President of the Federation of British Industries, was, at a recent meeting of the Grand Council, nominated for a second year of office. Lord Dudley Gordon is chairman of J. and E. Hall, Ltd., of Dartford, Kent, and is a former President of the British Engineers' Association.

THE LATE MR. W. S. EDWARDS.—We regret to have to record the death of Mr. Wodehouse Samuel Edwards, M.I. Mech. E., A.M.I.E.E., at Bexley, Kent, on December 26th. Mr. Edwards served his time with Messrs. Siemens at Gloucester, and afterwards worked with Messrs. Spencers, Melksham, Wilts, later going to Willans and Robinson, Ltd., Rugby. During the last war Mr. Edwards was lent by Willans and Robinson to the Admiralty and returned to them at the cessation of hostilities. In 1919 he joined the Fraser and Chalmers Engineering Works of the General Electric Company at Erith and occupied a prominent position in the material handling department, and was responsible for handling large schemes in this country and abroad. Mr. Edwards was sixty-two years of age.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institution of Automobile Engineers

Saturday, Jan. 25th.—LUTON CENTRE: George Hotel, Luton. "Producer Gas for Road Vehicles," M. Platt. 2.45 p.m.

Institution of Civil Engineers

Tuesday, Jan. 21st.—Great George Street, Westminster, S.W.1. "The Design of Sewage Purification Works," H. C. Whitehead. 1.30 p.m.

Institution of Mechanical Engineers

Friday, Jan. 24th.—Storey's Gate, Westminster, S.W.1. Presentation of James Watt International Medal. Lowe Gray Lecture, "Progress in Marine Engineering as Influenced by the Classification of Ships," S. F. Dorey. 2 p.m.

Junior Institution of Engineers

To-day, Jan. 17th.—Mining Institute, Newcastle-upon-Tyne. "Optical Instruments: Particularly Large Astronomical Telescopes," G. E. Manville. 6 p.m.

Saturday, Jan. 25th.—39, Victoria Street, S.W.1. "Protective Coatings on Metals," P. A. Cartwright. 1.30 p.m.

Royal Society of Arts

Wednesday, Jan. 22nd.—John Adam Street, Adelphi, W.C.2. "Flight Refuelling," Sir Alan Cobham. 1.45 p.m.